

MEDICAL ESSAYS

AND

OBSERVATIONS,

ABRIDGED

from the Memoirs of the Royal Academy.

V O L. IV.

CONTAINING

ELEMENTS of CHEMISTRY.

The Principal CHEMICAL Papers.

Some CHEMICAL ANALYSES, with a View
to the Improvement of PHARMACY.

By THOMAS SOUTHWELL, M.D.

L O N D O N :

Printed for J. KNOX, Bookseller, in the STRAND.

M,DCC,LXIV.

MEDICAL ESSAYS

AND

OBSEKVATIONS

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From the Memoirs of the Royal Academy

OF THE

COMMISSION

TO ENQUIRE INTO THE

CAUSES AND EFFECTS OF

THE SMALL POX AND MEASLES

IN THE CITY OF LONDON

IN THE YEAR 1721

LONDON

Printed by J. Sturges, at the

MEDICAL ESSAYS AND OBSERVATIONS.

Of Chemistry.

CHEMISTRY is the art of decompounding bodies, that is, of resolving compound bodies into their more simple parts, and by combining these together, to reproduce the original compound with all its properties, and even to compound new bodies, from the different mixtures of other bodies, and that by the help of *fire*.

The object therefore of Chemistry is all bodies, which Chemists have divided into three classes or kingdoms; in the first class are comprehended all fossils, or what is more generally understood by the name of minerals, which are generated either in the bowels of the earth, or under its surface: the second class contains all vegetable substances that grow, either on the surface of the earth, or under the waters: the third class comprehends all kinds of animals that live on the surface of the earth, or under the waters.

All those different substances yield by their *analysis*, nearly the same principles, but in different

ferent proportions, *viz.* a *salt*, a *sulphur*, *water* and some portion of *earth*. The great variety observable in all bodies, is intirely owing to the different combinations of those principles, among which the *sulphur* is the only active principal, that sets all the others in motion*.

As for the *earth*, it is said to be purely passive, fit only to retain as a *matrix* the other principles. The salt and water are called secondary principles, which when combined with the *sulphur*, become then capable of forming an infinite number of combinations.

The *salt* and *sulphur* of bodies can never be had by us, otherwise than combined with either the *water* or *earth*, which serve them as a *matrix*, whereas the *water* and *earth* may be had separate.

Salt is supposed to be a concretion of water, earth, and a portion of *sulphur* or *phlogiston*, soluble in water, fusible in the fire, affecting the

* We shall see hereafter, that what is here meant by *sulphur* is the *phlogiston*, or pure matter of *fire*, contained in a greater or lesser proportion in all bodies, but in the greatest of all, in all inflammable substances. Now, the Chemist must allow, that *fire* is the most powerful Agent he can employ to decompose bodies, and that the greatest degree of *fire*, producible by art, is excited by the rays of the sun, collected in the *focus* of a large burning glass, to which the Chemist is in a more especial manner indebted for the many secrets he extorts from *Nature*. As therefore this *sulphur* is no other than the pure matter of *fire*, collected and retained in the greatest proportion in all inflammable substances, may it not with some propriety be called, *the active principle that sets all the others in motion?*

the tongue with that sensation we call *sapid*; we find three different species of salts which answer to this character;

The first of these simple salts is called an acid, on account of its taste, which is like that of vinegar, and such four things, by which it is chiefly known; it has besides, the property of changing the blue and violet colors of plants or their infusions to a red; this is considered as the characteristic of an acid, distinguishing it from all other salts. The second is called a volatile alkali, distinguishable by the brisk, disagreeable impression it makes on the nose, not unlike what exhales from putrefied urine; on that account it is also called an urinous salt. Both the acid and this alkali are said to be volatile, because they are found to rise in sublimation or distillation with the least degree of *fire*. The third species of simple salts is called a fixed alkali, distinguishable from any other by the rough, acrid taste it leaves on the tongue, like what a burnt coal is known to leave, which is widely different from sourness, it destroying the acidity of every kind of sour liquor, dissolving sulphur by boiling, and changing the color of blue and red flowers to a green: it is also called a lixivial salt, from the manner it is procured, by several lotions in water, from the ashes of such substances as had been before calcined; and a fixed salt in opposition to the two preceding

ceding salts, because it is found to resist the greatest action of *fire*.

We never find any of these species of salts, otherwise than combined with other bodies, from whence they are separated by art, *viz.* from vitriol, nitre, sea salt, and tartar. The acid extracted from these saline substances is the simplest kind of salt we know; it is only in this sense that salt is called a *principle* in Chemistry, whose characteristic is not to be resolvable into more simple bodies, by any art of ours.

The form acids commonly appear in, is that of a transparent liquor, owing to their great affinity with water, which they greedily im-
bibe, even from the air, so as to acquire above six times their own weight *. Acids are likewise known to have a great affinity with certain earths and metallic substances, but the greatest of all with the *phlogiston*.

What figure salts are of, no one hitherto has been able to determine; but if we may judge of their figure from their effects, probably acids are a congeries of inflexible, solid parts, of an oblong angular figure; their dissolving solid bodies, declare their parts to be rigid and hard; their pungency on the tongue, extremely different from the corrosion of acrid salts, evinces their angular figure. The alkali (both volatile and fixed) is also a congeries
of

* Neum. Chem. p. 161.

of spherical particles with rough surfaces, containing a certain quantity of acid, the fire cou'd not intirely deprive it of, entangled in a portion of the earth and oil of the body it was obtain'd from. Some operations in Chemistry seem to confirm this origin of acrid alkaline salts, where by combining acids with certain earths, alkali's are produced, as we see in the preparation of fixing nitre, and fermentation of urine; that the volatile alkali contains an oil, is manifest from its deflagrating with nitre, which wou'd never happen without the immediate contact of some inflammable matter.

When we consider acids in their own nature, pure and free from all mixture with other bodies, we might probably find but one kind of acid in all *Nature*; and yet when we consider those acids as we obtain them by distillation, from either the mineral, vegetable or animal kingdoms, we never find them but combined with some sulphurous matter or other, which is inseparable from them by any art or industry of ours; probably it is to this sulphurous inflammable matter that all acid liquors, improperly called spirits, owe their power of dissolving metallic and other substances, and what characterises the difference observable between acid liquors, of which Chemists acknowledge four different kinds, known by that of the vitriolic, nitrous, marine and vegetable acid.

The

The vitriolic acid is diffused thro' the whole Creation, and on that account is considered by most Chemists, as the *basis* of all other acids, whether mineral, vegetable or animal, differing from it only by a certain combination of the *phlogiston* or inflammable principle, by means of putrefaction; as this acid is extracted equally from all the kinds of vitriols, the green, blue and white, from sulphur and alum, it is evident the acid is the same in these three saline substances, differing only in their bases.

When the vitriolic acid is united with alkaline salts, fixed or volatile, it cannot be expelled from them by any degree of fire, nor is it separable any other way but by transferring it into some third body, it has a greater affinity with; it has moreover this peculiar property above all other acids, which seems to enforce its *primogenial* origin, that it will expel all acids from any alkali or absorbent earth they may be united to, and taking their place, forms a concrete salt of this or the other kind, according to the nature of the alkali or absorbent earth it is then united to, and yet this same vitriolic acid is observed to act more languidly on most bodies, than either the nitrous or marine acids it expels from their respective *bases*.

The better to understand the reason of this, we shou'd carefully distinguish what *power*,
activity

activity and *strength* in acids are, they being three properties independent of one another, tho' commonly confounded together. Thus the vitriolic acid may be more *powerful* than any of the other acids, and in this sense expel them from all alkalies, both fixed or volatile, and soluble earths, and take possession itself of the alkali or earth; and yet it may be *less active*, or act more languidly and difficultly than either the nitrous or marine acid; the vitriolic acid in its concentrated state is the strongest of acids, because it then contains the greatest quantity of pure acid in proportion to the *flegm* or water, and when it is weakened by dilution, it still continues the most *powerful*, and even then its *activity* is oftentimes increased; the vegetable acid may be made *stronger* than the marine, and yet remain less *powerful*, for it will be always expelled by the marine acid from all alkali's and earths *. The nitrous acid, from its being generally obtained by elixation, &c. from the ruins of old-buildings, squalid earths of stables, pigeon-houses, privies, church-yards, places well known to be highly impregnated with either vegetable or animal salts, M. *Homberg* on that account ranged it with the vegetable and animal acids; but when we consider the general properties of this acid, as being the *most active* of all the acids, and more *powerful* than the marine acid, expelling

* Neum. ibid. p. 162. Note q.

expelling it from all alcali's and soluble earths, we must look upon the nitrous acid to be no other than the vitriolic acid, altered by putrefaction and commixture of some inflammable matter ; in proof of this, an experiment is alledged, in which the nitrous acid returns back into the vitriolic ; if two ounces of good spirits of nitre and half an ounce of the oil of turpentine be digested together, a balsam of sulphur is produced, possessing all the properties of the common balsam of sulphur. The question here rises, whence cou'd the vitriolic acid be here furnished but from the nitrous acid employed *.

The nitrous acid is observed to have a great affinity with fixed and volatile alkalies and soluble earths, and even a greater with the *phlogiston* than with the alkalies, but not so great as the vitriolic, which therefore expels it, even from its own *basis*, forming with it a vitriolated tartar, differing in many respects from nitre, both in the figure of its crystals and other sensible qualities ; the marine acid, so called from its being obtained from sea-salt, is like the nitrous acid, an off-spring of the *primordial* or vitriolic acid, and consists of that acid combined with the inflammable principle, and a peculiar earth, (by *Stahl* and others called a mercurial earth) endowed with properties, which distinguish it from both the vitriolic and nitrous acid.

The

* Neum, *ibid.* p. 195.

The marine acid has not so great an affinity with alkalies or absorbent earths as the vitriolic or nitrous acid; it is therefore expelled from them, and from its own *base* by either of them; the acid thus expelled is called the spirit of sea salt, which upon being combined with the *phlogiston*, forms a sulphur, differing in many respects from the common sulphur, but particularly in its taking fire upon being exposed to the open air; this is the phosporus, which still resembles sulphur, in being soluble in oils, melting with a gentle heat, easily inflamed, casting like sulphur a vivid, bluish flame.

This same spirit of salt, combined with a vegetable fixed alkali, forms what most chemists call (I apprehend improperly) a regenerated sea salt, for 1st, this is of a sharper and more pungent taste than the genuine natural sea salt. 2dly, It imbibes more readily the moisture of the air than the natural salt. 3dly, the *basis* of this regenerated salt is a vegetable fixed alkali, the creature of fire, consequently essentially different from the native mineral alkali, the *basis* of sea salt and *natron* of the ancients. Besides, the natural *basis* of sea salt has some properties peculiar only to itself. 1st, It crystalises like a neutral salt, which no other fixed alkali is observed to do. 2dly, It does not grow moist in the air, but rather calcines into a fine *farina*. 3dly, When combined with the vitriolic acid, it forms a true *Glauber's salt*, widely

different from vitriolated tartar in the figure of its crystals, which are oblong and hexangular, 2dly, by being more easily soluble in water, 3dly, By flowing with a very moderate degree of heat, whereas vitriolated tartar requires a fire of fusion to make it flow.

Lastly, as to the vegetable acid, this in a more especial manner, shou'd be considered as the true off-spring of the universal acid, which is constantly attracted by the plant, shrub or tree it is had from along with the sap, combined with a certain portion of the inflammable principle; and probably the only difference between this, and the mineral acids is owing to the several divisions and sub-divisions the universal acid undergoes, from the time it enters with the sap the root of the plant, shrub or tree, till it contributes to form the flower, fruit, or seed it is after extracted from; and as all animals live, and are nourished by vegetables, or live partly on vegetables and animals that live, and are nourished by vegetables, so it is evident the acid of animals does not differ essentially from the vegetable acid: this is further confirmed by M. *Homberg's analysis* of the blood; the reddish acid liquor that came over, agreeing in every thing with the acid of vinegar*.

When an acid is combined with an alkali (fixed or volatile), a concrete salt is then formed;

* See hereafter the analysis of the blood.

ed ; the impressi^{on} this salt makes on the tongue is more dull and languid than what either the acid or alkali separately wou^d make ; probably this may be owing to the largeness or bulk of the molecules this new salt acquired by the union, which renders them less disposed for motion ; this salt is also called a neural salt, by reason it never ferments with either an acid or alkali.

Concrete salts are again distinguished by the acids in their composition ; all the natural, concrete salts we know are, vitriol, alum, sulphur, nitre, sal-gem or sea-salt, sal-ammoniac and tartar.

The vitriolic acid combined with certain metalline earths forms the different kinds of vitriols, as green, blue and white, with a particular species of earth, alum, * and with any oil, whether mineral, vegetable or animal a sulphur.

The nitrous acid with a vegetable, fixed alkali, forms a true nitre, in hexagonal prisms ; but with a mineral alkali, a quadrangular nitre, different in many respects from true nitre.

The marine acid combined with a mineral alkali, forms a true marine salt in cubic crystals ; with a vegetable fixed alkali, what is called a regenerated sea salt. See before p. 9.

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The

* See hereafter of alum.

The vegetable acid combined with a vegetable fixed alkali, forms a true *tartarus regeneratus*, and with a mineral alkali a *sal de Seignette*, so called after the inventors name, which is no more than crystals of tartar, render soluble by a mineral alkali *. All acids combined with volatile alkalis form volatile concrete salts of a peculiar nature, the most common and remarkable species of this volatile concrete salt is the *sal-ammoniac* of the shops, which is so volatile as to rise intire in sublimation; this salt, as containing the marine acid, is simply called *sal-ammoniac*, all other volatile concrete salts are called after their acids, *viz.* nitrous *sal-ammoniac*, vitriolic *sal-ammoniac*: this last is also called *Glauber's secret sal-ammoniac*, after its inventors name.

When an acid is mixed with an alkali (fixed or volatile), an effervescence and ebullition always ensues, attended with considerable hissing, heat, and vapors, whence probably the notion of calling the acid the *male*, and the alkali the *female*, and the compound hermaphrodite, the alkali the *vacuum*, the acid the *implent*; the alkali the *Chaos*, the acid the impregnating spirit.

This seeming conflict between acids and alkalies may, perhaps with more propriety, be considered as an amicable association of two bodies, that had been only separated by the violent

* See hereafter of *sal de Seignette*.

lent action of fire ; in this case, they only re-possess those places they occupied before ; this is further elucidated by the experiments of Drs. *Hales* in his *analysis* of air *, and *Black* on *magnesia alba*†, whereby it appears that all alkalies contain a prodigious quantity of unelastic (fixed) air, which they so strongly attract, as in their ordinary state to be fully saturated with it.

Now, when an acid is mixed with an alkali, the fixed air is necessarily expelled ; because the attraction between the acid and alkali is still stronger than between the alkali and fixed air. This air being now set at liberty, expands itself, and rushes forth with *impetus*, producing effervescences, &c. that this expelled air is the genuine cause of those effervescences, observable on the mixture of an acid with an alkali, is evident from this, that when the alkali is deprived of its fixed air by fire, the acid saturates it quietly, without exciting either effervescence or ebullition.

As all concrete salts constantly assume a certain, determinate figure in their crystallizations, by which they are readily distinguished, some wou'd infer from thence, that this determinate figure is intirely owing to the acid ; others again as M. *Homborg*, will have it to be owing to their base only ; as a proof of this he instances the different crystals, the nitrous acid, for example, forms with different bases.

This

* Statical Ess. vol. 1.

† Literary Ess. vol. 2. p. 157.

This nitrous acid with salt of tartar, forms crystals of a prismatic figure; with copper, hexagonal crystals; with iron, quadrilateral somewhat irregular ones; silver with the same acid crystallizes into thin, triangular, indented plates; mercury with the same acid forms pointed, diamond-like cut crystals; silver and mercury dissolved in the same nitrous acid, shoot into crystals, resembling a shrub or tree; this is the *arbor Dianæ* of *Homburg*; lastly with lead, the crystals resemble little tufts.

This however is not universally true; for the same base forms different crystals with different acids; the *basis* of *Glauber's* salt and sal-gem is the same, the *basis* of nitre, vitriolated tartar and regenerated sea salt is the same; yet the form or figure of the crystals of all those salts is as different as possible; wherefore it is more probable that this determinate figure does not depend on the *base* alone, nor on the acid alone, but is rather owing to the combination of both.

Acids, as solvents are found to act upon earths and stones, metals and metallic substances, forming several compounds with them.

Stahl considering earths and stones, according to their chemical properties only, divides them into vitrescible and invitrescible or calcareous; tho' this division might have its use, yet they may with more propriety be divided into the crystalline, calcareous, gypseous, argillaceous

ous and talky ; the cryſtalline comprehend all bodies of that hardneſs as to ſtrike fire with ſteel : Acids never act on thoſe, either in their natural or calcined ſtate. This claſs comprehends all ſtones of the flint kind, cryſtals and gems.

The calcareous take in all earths and ſoft ſtones, reducible by fire into quick lime, and ſoluble by acids both in their natural and calcined ſtate ; ſuch are chalk, lime ſtone, the *osteocolla* found in ſandy grounds, in ſeveral parts of *Germany*.

The gypſeous contain all ſuch earths, and ſoft ſtones as are reducible by a moderate fire into an inſipid calx, forming with water a tenacious paſte ; in their natural ſtate not acted upon by acids, but after calcination become ſoluble by acids ; theſe are the *lapis specularis*, *selenite* or moonſtone, the *bolonian* ſtone.

The argillaceous comprehend all ſuch earths and ſoft ſtones as with water become ſo ductile and cohesive, as to be eaſily formed into any figure, and upon being expoſed after to the action of fire, acquire a degree of hardneſs, greater and greater in proportion to the vehemence and continuance of the fire ; theſe are the baſes of all earthen wares : Such are all the boles, as the *Armenian*, red and white of *Tripoli*, ſo called from *Tripoli* in *Barbary*, from whence it was firſt brought to us, but is now found in many parts of *Europe*, as in the Iſland of *Corſica*,

sica, in *Ischia*, at *Bayonne*, and in several hills in *France*, where it is found, lying in *Strata* a foot thick, and *lapis nephriticus*, so called from its imaginary virtues against nephritic disorders; it is found in new and old *Spain*, in *Switzerland*, *Saxony* and *Bohemia*.

Lastly, the talky earths and stones are soft stony concretes, not acted upon by any acid, and scarce calcinable by fire; among those are the *Venice* talc, the solar talc, the *amianthus*, or *asbestos* of the shops, and the punice stones found near volcano's; the whitest comes from *Mount Ætna* and *Vesuvius*.

Metallic substances are divided into metals, which are fusible by fire, concrescible by cold and malleable under the hammer; and when broken, appear of a bright uniform, fibrous or granulated texture, and into semimetals, which are heavy, opaque bodies, whose broken surfaces appear composed of large, angular flakes, and are not malleable under the hammer.

Metals are again divided into perfect and imperfect; the perfect metals are gold and silver, so called, because they suffer no alteration by fire, and even when corroded by acids into the appearance of a *calx*, are recoverable into their pristine metallic form, without any other additament, but what absorbs their solvent acid.

The imperfect metals are lead, copper, iron, and tin, so called from their being easily calcinable

cinable in an open fire, and when in that state, or when corroded by acids, they are not revivable again into their metallic form, without the addition of some inflammable matter ; for that these metals contain an inflammable matter, is evident from their deflagrating with nitre ; even some of them emit visible flames by themselves ; this inflammable principle, or *phlogiston* is the same in the mineral as in the vegetable and animal Kingdoms, as is evident from this, when metals are by fire deprived of their own *phlogiston*, if they be fluxed with any inflammable matter from vegetable or animal substances, such as pit-coal, charcoal, resins, ols, animal fats, &c. they are instantly revived into their pristine metallic form, and restored to their former splendor, with all their properties.

What this *phlogiston* is, is universally the least known of all the component parts of bodies ; many authors confound it with common sulphur, mineral bitumens, vegetable and animal oils, &c. but how widely different is the *phlogiston*, from any of those, or any other inflammable substance ! if every thing that burns was to be called the *phlogiston*, we might with equal propriety call every thing that is liquid by the name of water, such as all acids, ardent spirits, vinegar, oils or any other particular liquor* ; this great confusion and obscurity

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* Neum. p. 165.

among authors concerning this *phlogiston*, makes an inquiry into its genuine nature the more necessary.

M. *Homberg* in his Memoir for 1705, tells us that common sulphur, bitumens, oils can never be his *souffre principe*, this *phlogiston* of all bodies, as they are resolvable into other more simple parts, *viz.* into water, an insipid earth and a salt, while the *phlogiston*, which served as a cement to unite them, and which constituted them a sulphur, a bitumen, &c. irrecoverably exhales in lucid flames, *maugre* all the care and industry of the artist.

As therefore this *phlogiston* is in its own nature incoercible, and can never become manifest to our senses, otherwise than combined with those inflammable substances it inhabits as in a matrix, differently modifying them, increasing both their weight and bulk, so M. *Homberg* conjectures this *phlogiston* is the simple, elementary matter of fire, the only active principle in all nature, capable of penetrating all bodies, diffusing itself with a kind of uniformity and equality thro' all their interstices, and preserving, while thus imprisoned, all the known properties of bodies, as impenetrability, gravity, &c.

That the matter of fire, does increase the weight of all such bodies it is imprisoned in, we have a pregnant proof in the following experiment.

M.

M. *Homberg* took 4 ounces of *regulus martis* in powder ; he placed it at the distance of a foot and a half from the true focus of the Duke of *Orlean's* grand *Lens*, for the space of an hour, stirring it now and again with an iron rod, while any fumes did rise: one might reasonably expect that this *regulus* shou'd rather lose, by the avolation of some of its parts in those thick fumes than gain in its weight after the operation ; however, it was found to have increased 3 drams, which is about one tenth of the whole. M. *Homberg* willing to see if this *regulus* wou'd retain this additional weight it acquired, placed it in the true *focus* of the *Lens*, where it was speedily converted into an orange-colored *vitrum*. It now weighed but 3 ounces and a half, the loss was one eighth, besides the 3 drams it acquired in the first operation. By this experiment it appears, that the *regulus* lost in the thick fumes in the first operation half an ounce, which with the 3 drams it then also acquired, make 7 drams, the 4 ounces of *regulus* received from the matter of fire, during an hours calcination.

Macquer agrees herein with M. *Homberg* " the phenomena attending the combustion of inflammable substances shew, they really contain the matter of fire as a constituent principle. — How it comes to be so fixed as to make a component part of the most solid bodies, is not easy, satisfactorily to account for ;

but let us rest contented with the certainty of the fact, the knowledge of which will undoubtedly procure us considerable advantages.*"

Acids as solvents penetrate all alkalies (fixed or volatile), soluble earths, and some of them act with great force, and others but feebly on metals; when they act with so much force as to burst and tear asunder those substances they penetrate, rendering their parts so small as no longer to appear visible to the eye, this is called the dissolution of bodies.

Acids do not with equal facility dissolve all kinds of metals; the vitriolic acid, for instance, in its diluted state will dissolve iron and copper; it will also dissolve silver, but then it must be concentrated, and in double the weight of the silver; nor will it yet succeed, without a considerable heat †. Mercury, tin, lead, *regulus* of antimony are corroded by boiling them with this concentrated acid; but gold by no management is acted upon by it in its most concentrated state, and yet it is found to have a greater affinity with metals than the acids that dissolve them, if added to a solution of silver in the nitrous acid, it will dislodge the solvent acid, and carry the metal to the bottom; but there is this exception; for the marine acid will carry down the silver dissolved by the vitriolic, as this did from the nitrous acid; tho' the

* Elem. of Chem. p. 9.

† Ibid. p. 53.

the vitriolic like all other acids quits the metal it has dissolved, upon adding an alkali (fixed or volatile), yet in some circumstances it discovers a greater affinity with some metals than with fixed alkalies, if vitriolated tartar be added to a solution of mercury or silver, the vitriolic acid instantly forsakes the alkali, unites with the metal, and dislodging it from its former solvent, precipitates with it to the bottom *.

The nitrous acid either dissolves or corrodes all metallic bodies, except gold, and even this by a small admixture of the marine acid. It dissolves iron, copper, lead, mercury, silver, bismuth, zinc more readily and violently than any other acid. Tin it dissolves but imperfectly, and regulus of antimony it only corrodes into a powder.

The marine acid easily dissolves zinc, iron, and copper; it acts with more difficulty on tin, and scarcely at all, tho' assisted by a considerable heat, on silver, mercury, lead or regulus of antimony, and gold it will not dissolve, without being combined with the nitrous acid †. Tho' this acid in its liquid state can-

* Neum. p. 172. Note a.

† Dr. Brandt in the *Swedish Trans.* for 1748, observes that the marine acid wou'd, in certain circumstances, dissolve gold, when reduced into the form of a *Calx*, either by precipitation from other *menstrua*, or by calcination with tin or other calcinable metals, the marine acid wou'd then perfectly dissolve gold, and keep it permanently dissolved, *apud Neum.* p. 33.

cannot dissolve silver, yet if to a solution of silver in the nitrous acid, you add the marine acid, the nitrous acid is instantly dislodged, the marine unites with the silver, and precipitates with it to the bottom; this precipitate fuses easily, and becomes in some measure transparent and flexible, whence the name of *luna cornea*; if you wou'd separate the acid from the silver, flux this *luna cornea* with some fatty, absorbent matter, in order to absorb the acid; the metal will be left exceeding pure.

This property of the marine acid of dislodging silver from its only solvent acid is exactly agreeable to the table of affinities, wherein the marine acid is put in the 8th head column, as having a greater affinity with metals in general, than either the nitrous or vitriolic acid*.

The vegetable acid has the same properties as the mineral acids, unites equally with alkaline salts, soluble earths and metallic substances, forming with them neutral saline compositions; its affinity with those substances observes the same order as that of the mineral acids, but it is weaker, owing partly to a certain portion of oil, it is always clogged with, which the minerals have not, and partly to a great quantity of water, wherein it is greatly extended, and is for that reason readily expelled by them from any body it is united to.

This

* See hereafter the table of affinities.

This acid is found to have a greater affinity with alkalies than sulphur has; it precipitates the sulphur joined to the alkaly in the *hepar-sulphuris*; it also dissolves lead intirely, and converts it into a neutral metallic-salt, called *sal saturni*. Lead exposed to the bare vapor of vinegar, is calcined, and converted into a white mass, called white lead, and also ceruse, much used in painting; copper is in like manner corroded by the vegetable acid, and converted into a beautiful green rust, known by the name of verdigrise.

How acids dissolve metals, M. Homberg conjectures is thus, he supposes acids to be solid angular bodies, wrapped up and combined with the *phlogiston*, the only active principle in all nature; these acids thus armed, entering the pores of metals, separate their component parts asunder, and keep them suspended after in the *menstruum*.

M. Homberg further observed that acids dissolved more of some metals than of others, that they dissolved some, both more readily and with more facility than others, especially, if those acids were stronger, or in the chemists language were well *deflegmated*; for instance, the nitrous acid, that wou'd readily dissolve silver, wou'd only corrode lead; it therefore wou'd require to be diluted, *i. e.* have 5 or 6 parts of water added to it, and even when
more

more water is added, it will still dissolve iron and copper.

And here a very curious observation naturally presents itself, in those dissolutions of metals by acids, *viz.* that an acid will frequently quit the metal it dissolved with difficulty, when a certain other metal, it is known to dissolve with more facility, is presented to it; for instance, if to a solution of silver in the nitrous acid (first weakening the acid by the addition of some water), you put a thin plate of copper, the nitrous solvent will instantly abandon the silver to attack copper; the silver abandoned by its solvent, gradually precipitates to the bottom: when the copper is intirely dissolved, if you put a thin plate of iron into the solution, the nitrous acid will here as readily abandon the copper, as it did before the silver, to fasten upon the iron; in proportion as the solvent acid dissolves the iron, it lets go the copper, which gradually precipitates to the bottom, as the silver did in the first experiment.

It is after this manner that the pretended conversion of the work-men's tools happens in all copper-mines, the vitriolic acid, known to abound in all copper-mines, having a greater affinity with the *basis* of iron than with that of copper, quits this to join the other; in proportion as the viriolic acid dissolves the iron, the copper now abandoned by its solvent, necessarily precipitates, and gradually falling on those iron-tools, it adheres to them, crusting them over, so as to give

give them every appearance of their being copper, both as to their form and metal.

And here it is very probable, that it was from this observation of M. *Homburg's*, concerning the manner mineral acids abandon one metal to fasten upon another, that M. *Geoffroy* the elder took the hint to compose his table of comparative affinities, which in the opinion of the learned in this art, has been of more real service to chemistry than any thing that has hitherto appeared in that way; for by the help of this table, those who intend to study chemistry, will be better able to form a just notion of the relations, which different substances have with one another. Besides, the practical chemist is hereby enabled to account more satisfactorily for the various, and often uncommon *phenomena*, that occur in the several processes he makes, and judge what ought to result from the combinations of different substances, which before puzzled even the ADEPTS.

Though this table was not published till the year 1718, I thought it proper it shou'd precede the chemical papers, the more so, as I all along made references to it, but for a more particular reason, as it collects into one point of view, the most essential and fundamental doctrines of elective attractions or affinities, which are observable in all the processes contained in this volume.

And as *fire* is the chief agent the chemist employs in all his operations, whether in decomposing bodies or compounding new ones; and as its power is so great, its effects so extensive, and manner of acting so wonderful, that history informs us, that some of the wisest nations worshiped it as the SUPREME DEITY, I have also added, M. *Lemery* the son's dissertation on *fire*, being in my opinion the most succinct account of this wonderful element to be met with any where, and from which M. *Boerhaave* indisputably must have borrowed most of what he has said on that subject in his elements of chemistry, tho' he never once mentions *Lemery's* name, which must surprize us the more, as he makes honorable mention of other members of the same Academy, as Mess. *Homborg*, *Amontons*, and particularly the later. This curious gentleman invented a thermometer, by which he discovered, that water once made to boil, is never after capable of becoming hotter, or receiving more particles of *fire* between its interstices, tho' one shou'd increase the *fire* ever so much.*

M. *Boer-*
 * *Fahrenheit* has since discovered, that the heat of boiling water becomes so much the greater, as the air is heavier, i. e. he observed that when the *mercury* was at the highest in the barometer, the intenseness of the heat of boiling water was then considerably increased, and was as considerably lessened when the *mercury* was at the lowest.

Water impregnated with sea-salt, or with the vitriolic acid is known to acquire a greater degree of heat upon boiling than pure water.

M. *Boerhaave* speaks with high raptures of this discovery ; " the candor which I feel within my breast at present, and which I hope I shall always have the pleasure of, obliges me to acknowledge in this PUBLIC MANNER, that nothing has been of greater service to me in the discovering the usefulness of fire in the deepest chemical inquiries, or better helped me to come at the knowledge of the properties of this element than this valuable experiment of this noble author ; but I refer you to the fountain, the Memoirs of the Royal Academy of Sciences." See *Boerb. Chemist. Dallow's Edition*, p. 104.

This extraordinary *elogium* of M. *Amontons* with so total a neglect of M. *Lemery*, must I apprehend, leave an everlasting blemish on the candor of so great a chemist as M. *Boerhaave* really was ; might he not, with equal justice, refer his readers to M. *Lemery's* Memoir on the nature of fire, contained in the same Memoirs, as to that of M. *Amontons*, especially as he cou'd not but know, that such as shou'd read those Memoirs, and into whose hands his elements of Chemistry might come, must unavoidably see, ' that he was as much indebted to *Lemery's* Memoir on fire, which perhaps helped him as much in the discovering the usefulness of fire in the deepest chemical inquiries as *Amontons* valuable discovery.'

This I am a witness of, that as duly as M. Lemery opened his course of Lectures on Chemistry in the *King's Garden in Paris*, he as surely publicly charged M. Boerhaave with the *theft*, as he constantly used to call it, in stealing from him 'what he had most valuable in his account of fire, without ever mentioning his name; but added he, I shall one day let the whole world see the injustice M. Boerhaave has herein done me.'

Conjectures and Reflections concerning the matter of Fire and Light. By M. Lemery, the Son, 1709.

The matter of *fire* is the first and most powerful solvent of terrestrial bodies: We have no other that penetrates so deep, or so completely disjoins their component parts; it is to this matter the chemist is indebted for the secrets he extorts from *Nature*, which she never wou'd reveal to him, unless forced, and as it were tortured by so active a solvent; now, a matter that contributes so much to our acquiring the knowledge of other bodies, does most certainly deserve to be considered itself in its turn.

It is allowed to be the real principle of heat, light, and even of the fluidity or *fusion* of several terrestrial bodies, which without the admixture and action of this matter, wou'd always remain in a solid form; but as it is not
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always found in a sufficient quantity, or when it meets with bodies, which make too much resistance, we sometimes find, that instead of liquifying, or keeping those bodies it is mixed with in their former fluidity, it so engages itself, and becomes as it were imprisoned in the pores of said bodies, until some external cause comes to its assistance, and opens those pores it is so engaged in.

There are two remarkable circumstances relating to this imprisoned matter of *fire*, 1st, It sometimes sensibly increases the weight of such bodies it is contained in, 2dly, It retains all its peculiar properties during the whole time of its captivity ; as evidently appears, whenever it is set at liberty to act upon any other body.

Some men will not allow of what I here attribute to the matter of *fire*, they even alledge that such doctrine is inconsistent with our notion of what really constitutes the nature of *fire* ; yet this doctrine is supported by so many solid arguments, that several Chemists of the first rank have been obliged to adopt it ; to set this matter in a fuller light, and in order to apply this doctrine to the explaining of certain *phenomena*, both in this and in other Memoirs, I shall here set down such experiments, as serve to support the doctrine I have advanced, and at the same time answer such objections, as are brought against it, which notwithstanding all the verisimilitude experiments can give it, are
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it must be confessed, of force sufficient to bring its truth in question.

Every body knows that several metallic bodies exposed to the action of fire, such as *regulus* of antimony, lead, *tin*, and even *mercury*, notwithstanding that a great deal of their substance exhales, and flies off during the operation, yet they are found to weigh more after than before the operation: this question naturally arises, whence comes this augmentation of weight? undoubtedly the *fire* which reduced those bodies into this calcined state is what gave them this additional weight. It may perhaps be answered, that this augmentation of weight is owing to the acids in the wood, or charcoal used in the operation, and which by the action of the *fire* have penetrated those bodies, which acids still remain after the particles of *fire* are gone off; but it is not easy to conceive how a sufficient quantity of those acids cou'd reach the calcined body, so as to increase its weight to one tenth of the whole, as *M. Homberg* has observed. It is certain, that before these acids cou'd reach those bodies exposed to the action of *fire*, they must first penetrate the crucibles, imployed in calcining said bodies, which do not suffer those acids to pervade them easily; for it is known that the crucibles, employed in those kinds of operations are capable of retaining the strongest acids without suffering them to escape thro' their pores;

pores ; if therefore some of the acids of the wood shou'd find means to pass thro' the pores of those crucibles, yet the difficulty of their passing is so great, that the quantity of acids that cou'd pass, must be very small ; this will appear more evident, when we consider that the greatest part of these acids is stopped, and retained in the pores of the vessels, which from their own nature are very capable of retaining them ; on the contrary the matter of *fire*, passing freely and in great quantity thro' all kinds of vessels, as daily experience teaches us, this augmentation of weight must be laid to its account ; and as this increase of weight is often very considerable, so it necessarily presupposes a cause able to supply it, and such is the matter of *fire* ; but what seems clearly to evince this matter is this, when these same bodies are expos'd to the Duke of *Orlean's* grand *Lens*, their weight is equally increased, as when expos'd to the action of our common *fire* ;* in this case, all acids, from either wood or coal are precluded ; and let us make what other supposition we will, we shall find it difficult to exclude the matter of *fire*, from its part in this *phenomenon*.

Now, that this matter of *fire*, not only insinuates itself into certain bodies, thereby increasing their weight, but still that it retains there all those properties which constitute the essence

* See before p. 19.

essence of *fire*, is clearly evinced by dissolving all saline bodies that were calcined in water, the particles of *fire*, locked up in the pores of those bodies (lime for example), are set at liberty by the water, which becomes itself more or less heated, in proportion to the quantity of lime employed; why the particles of *fire*, contained in metallic bodies, do not manifest themselves, is owing to the solidity of those bodies, which nothing less than a fire of *fusion* is able of disengaging. But further to evince this matter, these calcined bodies contain so great a quantity of this matter of *fire*, and so readily part with it, that when they are applied exteriorly to an animal body, they are known to form an *eschar*, directly as the actual cautery wou'd: this certainly must be owing to the particles of *fire*, those bodies received in their calcination; the perspirable matter, in the case before us, sets those particles of *fire* at liberty, just as the water set those contained in the lime; as therefore the properties all calcined bodies acquire, are the same with those of our common *fire*, so the effects both produce must be accounted for after the same manner; let us consider here one particular instance; when quick lime is put into water, it renders it hot, and makes it boil as *fire* wou'd; shall we attribute this effect to fermentative particles contained in the Lime, and only put into motion by the water, when we find nothing in lime, but a meer

a meer earth, deprived of all its salts by calcination, in so much, that one may say, that the *fire* expelled all other bodies, to lodge itself in their place : how then a meer earth cou'd become capable of heating the water is impossible to conceive, unless we admit it contained particles of *fire*.

But it is alledged, that the particles of *fire* are such only, on account of the rapidity of their motion ; and tho' they may be supposed engaged in the texture of gross bodies, yet they must there soon lose their motion, consequently cease to be *fire*, and therefore become incapable of producing those effects attributed to them ; we must therefore have recourse to some other cause to account for those effects.

To this it may be answered, 1st, that *fire* is a fluid body of a certain nature, endued with peculiar properties, which distinguish it from all other fluid bodies : now, tho' these properties may in one sense depend on the rapidity of the motion of its particles, yet the very figure of these particles must necessarily be taken into the account ; however, whenever this fluid is retained in any body, its condition there is not worse than that of other fluids, while contained in any body ; water for example, is contained in several bodies, without losing its fluidity, or any of those properties which characterize it water ; for whenever it is by distillation drawn from them, we still find it endued with

all its usual properties. With how much more reason must the matter of *fire*, when in the same circumstances retain'd in any body, preserve all its properties, and upon its enlargement be found endued with its natural powers? if it shou'd be replied, that comparisons will never evince the matter, that the point in question is, whether the matter of *fire*, detain'd in bodies preserves its motion?

Before we consider this, it will be proper first to remove the following objection, the more so, as it will naturally lead us to the solution of the principal objection.

It must be allowed that the activity of the matter of *fire* is very great, and that whenever it is in a sufficient quantity to surmount the resistance offered by the body it is detain'd in, it makes its way thro', breaking the continuity of its parts; but the matter of *fire* is not always locked up in a sufficient quantity, so as to be able to effect this; and in that case, its force being inferior, or only equal to the resistance of such bodies, all its activity and efforts will be to little purpose, till some exterior cause comes to its assistance to set it at liberty.

The subtilty of the matter of *fire* must also be allowed to be very great; but the question will return, whether the pores this matter of *fire* is contained in, be not smaller than even these particles of *fire* they contain; as we have no *microscopes* fine enough, nor any other
sufficient

sufficient means to decide this matter, and as there is no inconvenience in supposing, that these pores are less than the particles of *fire*, we may admit the supposition, the more so, as we have incontestable arguments to prove, that the matter of *fire* is actually detained in the pores of several bodies; all this while I do not pretend, that those pores, thro' which the matter of *fire* cannot pass, are therefore impenetrable to all other kinds of bodies; for how small soever the particles of *fire* may be, I can conceive others a hundred times smaller, which may easily pervade all bodies, and whose office perhaps, it may be to fill up all the *vacuums* in nature; but still, tho' their smallness might exceed that of the particles of *fire*, they may not be so proper to produce the like effect, as *fire*, and for this reason; one chief property of *fire* is to dissolve and liquify terrestrial bodies; it produces this effect by dividing and disuniting their component parts, and giving each part so disunited the necessary motion to constitute the whole a fluid. Now, as this *subtile matter* so easily pervades all bodies, it as easily escapes thro' their pores, without making so strong an impression on them, as we find the matter of *fire* does, which matter of *fire* being less subtile, consequently unable to pursue the same tracts, is forced to break all the obstacles in its way,

destroying the natural texture of all such bodies it is detained in ; To illustrate this matter, let us consider the following fact ; if a net is spread across the stream of a river, the particles of water will in no wise damage it, because they find an easy passage thro' its *masbes* ; but if any body too big to pass thro' these *masbes*, shou'd come against it, this body must either stop or break thro' the net ; something like this happens to the matter of *fire*, which in proportion to its quantity and strength, is either detained in the bodies, or it dissolves them ; now, without the help of any comparison, to conceive how this matter of *fire*, inclosed in the pores of solid bodies still preserves its motion, we need only conceive, that a more *subtile matter* constantly pervades those same pores, which necessarily keeps up the agitation of the particles of *fire* inclosed therein.

M. Saurin has demonstrated, that the proper matter, even of the most solid bodies, does not make the one hundred thousand part of their bulk ; tho' we shou'd abate a good deal of this supposition, yet the most solid bodies will still be able to give a passage, and a lodgment to a large quantity of new matter, and in this case, the above *subtile matter* passing more copiously than we can well imagine, the particles of *fire*, notwithstanding their imprisonment, will be still able to maintain their
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fluidity and motion. But tho' we shou'd admit that the particles of *fire*, imprisoned in solid bodies, cou'd not always preserve their motion, yet it wou'd not follow from thence, that they did not retain their proper nature of *fire*; for the peculiar properties of *fire* do not depend upon the rapidity of their motion *solely*, but also upon their particular figure and size; for example, the particles of water when frozen are at rest; but who will say, that these particles of water are essentially different in this their frozen state, from what they were before, especially as the least agitation or smallest degree of *fire*, enables them to produce those effects, their peculiar figure made them fit for, and which no other body by the same degree of *fire* cou'd ever produce.

Salt every body knows, is the instrument or *medium* of taste, it is likewise endued with certain properties, arising from the peculiar figure of its parts, yet every body knows salt never acts 'till it is dissolved, or what amounts to the same thing, till it is suspended in some *menstruum* or fluid, which is capable to keep its angular, active particles in motion; now, who cou'd say, that salt in its undissolved state, is not still the instrument or matter of taste, or does not retain all those properties that characterise it salt, more especially as it retains its essential figure, on which the properties of all salts depend? therefore, tho' the particles of
fire

fire, by being inclosed in the pores of some solid bodies, might sometimes be deprived of their motion, in such a case, they cou'd not be in a worse condition than water when frozen, or salt undissolved are, and may therefore be restored to their former powers, by recovering their motion.

But shou'd it be inquired why this matter of *fire* does not escape, or get out of the pores of those solid bodies it had penetrated, and that without the help of any external cause ; since the passages were open enough to let it in, why not equally to let it out ? the answer is very easy. A body expos'd to the action of the fire, has all its pores open, of course greatly dilated ; during this action of the fire, several particles of *Fire* both enter these pores, and as easily come out, and continue so doing, while the action of the fire lasts, while the pores remain open ; but as soon as the action of the *Fire* ceases, the dilation of the pores ceases in like manner ; these pores then shrink, and gradually return to their natural diameters, whereby such particles of *Fire* as had insinuated themselves into the pores of such bodies, during the preceding action of the *fire*, are shut up after, beyond all possibility of escaping, until some subsequent dilatation of said pores, or a *fusion* of the body those particles of *fire* are contained in, sets them at liberty.

If

If we seriously consider this, we cannot be surprized to find, that such bodies as in their calcination, take in a large quantity of this matter of fire, excite upon handling them little or no sense of heat; for as the inclosed particles of *fire* cannot reach the hand, applied exteriorly only, the effect on the hand shou'd be the same, as if in reality there were no particles of *fire* contained in the body, the hand had been applied to. Something nearly similar to this is observable in salts, which never affect the tongue, 'till separated from all other bodies; then, and then only they affect the immediate organ of that sense, the tongue.

Whenever therefore bodies just taken from the *fire* excite any impressions of heat, this impression proceeds from those particles of fire, which as easily escaped out of the pores of such bodies, as they penetrated them, but does not proceed from those particles of fire we suppose are locked up in the pores of said bodies; for we may be allowed to suppose two kinds of pores in bodies, some always big enough to permit the particles of *fire* to escape, others only so, when dilated by heat.

Lastly, it may be asked why the matter of *fire* imprisoned in saline and other strong bodies, does not as well break its prison, destroy the texture of such bodies, as water does, which is allowed to be so much less active.

Here

Here it may be said that if the quantity of the matter of *fire* contained in lime (for example), was as great as the quantity of water poured upon the lime, the matter of *fire* wou'd undoubtedly in such a case want no external assistance to set it at liberty ; but notwithstanding all its natural activity, it might be in so small a quantity, in proportion to the quantity of water employed, that the particulars of water shall be more effectual to release the imprisoned *fire*, than the particles of *fire* themselves cou'd be ; and here it is certain, that the quantity of *fire*, produced from such calcined bodies, is much inferior to the quantity of water, employed to set these particles of *fire* at liberty.

But further. All alkaline fix'd salts are known to contain particles of *fire* ; water likewise, is known to dissolve these salts as speedily as *fire* cou'd ; wherefore, as water can as readily dissolve all alkaline salts as *fire*, it will in like manner as readily set at liberty all the particles of *fire* contained in the pores of these salts ; and as nothing less than a fire of *fusion* is able to set at liberty the imprisoned particles of *Fire* of all alkaline salts, so as these imprisoned particles are in less quantity, and of course less powerful than a fire of *fusion*, their effect on these salts must necessarily be less considerable than that of water ; and here we must not suppose that water pour'd on lime, or any other alkaline salt, does solely procure the liberty

berty of the imprisoned particles of *fire*, the matter of *fire* thus imprisoned, is continually making its utmost efforts to set itself at liberty, and tho' while in so small a quantity it cou'd not, without the aid of some exterior cause procures its liberty, yet when this aid comes, it contributes considerably to its own release.

The *sun*, that large body of *fire*, not essentially different from ours (for it produces the same effects on such bodies as are exposed to its action, as our *common fire*), as it is at so great a distance from us, cannot act upon terrestrial bodies otherwise than by emanations or effluxes of his substance emitted to us, (an hypothesis liable to many difficulties, and inadequate to explain certain *phenomena*) or by supposing trains of this matter of *fire*, diffused thro' all the intervals of that fluid mass between him and us, which when violently impelled by the presence of the *sun*, must necessarily act upon all terrestrial bodies. Each train of this celestial matter might easily be looked upon as a particular little *sun*, continued to us, but still depending on the mother *sun*, as the source of their distinct, separate actions upon all terrestrial bodies.

That all these several trains of luminous rays, or matter of *fire*, are of the same essence or *Nature* as the *sun* itself, experience evinces; consequently, as the *sun*, as a body of *fire*,

produces many effects on such bodies as are exposed to its action, in like manner as our *common fire* does, so we may be allowed to conclude, that the essence or *Nature* of both must be one and the same. Now, we know whenever any body is exposed to the action of our *common fire*, that it is the genuine matter of our *fire* that penetrates, heats, and differently modifies said body; and further. Whenever any body is placed near the *Fire*, the impression made on it is the same, as if the *Fire* had been immediately applied to this body, the difference being only according to more or less; so that a body acted upon by a small *Fire*, will be affected in the same manner as if it had been placed at a considerable distance from a large *Fire*.

By this it is evident, that the matter of *Fire* or light interposed between us and the flame, is of the same *Nature* as the flame itself; for the rays of light collected by means of a burning glass, act upon terrestrial bodies with equal, or even with more energy than the most violent fire we cou'd make. This evidently shews, that not only the matter of those rays is the same as that of *Fire*, but likewise that *Fire* consists only of a collection of a prodigious quantity of those rays, which act the more forcibly, as they are in a greater number and closer collected.

The

The *Sun* then differs from those rays of light, collected by a *Lens* in this only, that in the *Sun* the matter of *Fire* or light is collected in a greater quantity than in the rays; it wou'd therefore act, more readily and forcibly on terrestrial bodies cou'd they be immediately exposed to its action.

The violent action of the rays of light, when united by a *Lens*, evidently demonstrate that the atmosphere, thro' which they pass, serves to moderate their action, and render them supportable to us; for without such a *medium*, instead of enlightening us, and exciting a gentle warmth in our bodies, they wou'd consume all bodies, and destroy the very organ of vision.

To illustrate this by a familiar example: the atmosphere with respect to the rays of light, might be considered as water, with respect to the particles of *Fire* in a *Balneum Mariæ*; the action of these rays is moderated in their passage thro' the atmosphere, as that of the *Fire* is in its passage thro' the water; or those rays of light might be compared to corrosive spirits, which powerfully tear and separate such substances as are exposed to their action, while the same corrosive spirits make only an agreeable impression on the tongue, when properly diluted with a sufficient quantity of some other fluid.

This matter of *Fire* impressed by the *Sun* on terrestrial bodies, affects them differently; some it easily puts and preserves in a state of *fusion*; such are the particles of water, which are originally solid, but owe all their fluidity to the action of the matter of *Fire*, diffused thro' their interstices: this is evident by their fluidities remaining no longer than the *Sun* determines a sufficient quantity of this matter of *Fire* to act upon terrestrial bodies; for in those seasons, when the quantity of *Fire* emitted by the *Sun*, is not sufficient to maintain the *fusion* of these particles of water, they soon relapse into their former state of immobility, from which they recover only, when the *Sun* begins to emit a greater quantity of *Fire* to terrestrial bodies.

From what has been now said, we learn, First, that *ice* is only a restoration of the particles of water to their natural state. Secondly, that the absence of this matter of *Fire* is sufficient to effect this restoration. Thirdly, that the fluidity of water is as real a *fusion* of its component parts, as that of metals exposed to the action of the same *Fire*; the only difference is this, that metals require a great quantity of the particles of *Fire* to liquify and support them in a state of *fusion*, whereas a much less quantity of the same particles of *Fire* is sufficient to preserve water in a state of fluidity, and prevent its resuming its natural solidity,

solidity, as metals removed from the *Fire* do. Another effect of this matter of *Fire* upon terrestrial bodies is to engage itself, in certain compositions of salts, earths, water, where with them it forms oyls, *bitumens*, and in short, all inflammable substances, which are more or less so, as they contain a greater or lesser quantity of these particles of *Fire*. This is clearly evinced by the *analysis* of those oyls, *bitumens*, which are intirely reduced to a salt, earth and water; the *Fire* is that volatile substance which escapes thro' the closest vessels, and *maugre* all the artists care exhales in a sufficient quantity to lessen the weight of the remaining mass considerably *.

This is most certain, that salt, earth and water, whether united or separated, never wou'd become inflammable, but wou'd rather obstruct the inflammability of such bodies as are endued with that property; and what is more, the only use of said salts, &c. to inflammable bodies, is to receive and keep the matter of light or *Fire*, but which never appears in its own form, until it has broke open the pores or cells of those inflammable substances, thereby setting itself at liberty.

It is therefore the real matter of *Fire* that thus exhales in the *analysis* of all inflammable substances; and all that remains after the operation is the *matrix*, wherein this matter of *Fire*

* See before, p. 18, *et seq.*

Fire was lodged. We shall therefore easily conceive, how this matter of *Fire*, when free and left to itself, easily pervades the closest vessels, especially when we consider that there is no vessel, but what this matter of *Fire* will readily penetrate, so as to warm the fluid contained in it; and as to the cause of inflammability, we know by experience that salt, earth and water, put in what situation you will, can never become inflammable; consequently the above effects are properly and *solely* to be attributed to the matter of light or *Fire*, contained in the pores of such bodies, and from which all their properties proceed.

And here we shou'd not be surprized to find, that calcined metals, and all such bodies as in their calcination receive a good deal of this matter of *Fire*, do not as readily take *Fire*, as oils are known to do; for to effect this, it is necessary that the luminous substance, constantly issuing from such bodies, is both in quantity sufficient, and in vigor capable to act upon the atmosphere, so as that the particles of this *Fire* diffused thro' it, might successively strike each other, and thereby pursuant to the direct determination impressed on them, transmit these impressions of light to a greater or a lesser distance; but when a small quantity only of these particles of light exhale from solid bodies, they are soon absorbed by the atmosphere they are diffused thro', so as to become

come insufficient to make those impressions on us, or become sensible to our eyes.

Upon the whole then, we find that the matter of light or *Fire*, contained in inflammable substances, when exposed to the action of *Fire*, exhales every moment in much greater quantity than it does from calcined metals; whether it be, that these metals contain less of this matter of *Fire* than the oils, or whether their having a closer texture, they do not allow the matter of *Fire* so free egress as the oils do; but at each effort, the exterior agent, the *Fire* makes to set the imprisoned particles of *Fire* free, a few parcels only exhale, incapable of sensibly affecting the eye.

The following known fact, will help to set this matter in a clear light. Whenever the most inflammable substances, such as paper, straw, are exposed to too small a *Fire*, they consume intirely, without casting any flame; because the exterior agent, the *Fire*, is too weak to expell at once a sufficient quantity of the matter of *Fire*, lodged in the pores of such bodies; the whole matter of *Fire*, contained in such combustible substances flies off successively in little invisible parcels, proportionable to the force that procured them their liberty.

Here we might take an opportunity to account for several *phenomena*, which perfectly quadrate with this system of imprisoned *Fire*, and which are very naturally deducible from it,

it, in so much, that each *phenomenon* seems a kind of proof of the truth thereof; for how satisfactorily does this system account for all *phosphori*, both natural and artificial, and all those violent fermentations, accompanied with flame, which inflammable oils exhale, when penetrated with the nitrous or vitriolic acid? but were I to enter into a minute detail of all the experiments of this kind, and the particular circumstances which accompany each, I shou'd far exceed the bounds prescribed for this paper, and at the same time encroach on the subject of future memoirs; I shall observe here only, that all *phosphori* in general, may be considered as so many little sponges, filled with the matter of light, and which is so feebly retained therein, as to require very little aid to exhale, and appear luminous, nay even to burn and set on *Fire* such bodies as come in its way.

Upon the whole then it appears, that as the *Sun* is a kind of a large receptacle or fund of the matter of *Fire*, so we have an infinite number of smaller receptacles in all inflammable bodies, which seem to supply in due season the absence of the *Sun*. In short, the presence of *Fire*, being indispensably necessary to produce light and heat on this our earth, and this great luminary not being always on our *hemisphere*, but retiring in certain seasons to a great distance from us, or what amounts to

to the same thing, his determining only a small quantity of the matter of light upon terrestrial bodies, we find a happy substitute in the bowels of the earth, whereby to remove all the evils, into which the absence or distance of the *Sun* wou'd unavoidably throw us; I mean a sufficient quantity of the matter of *fire* to form a kind of little *Suns*, capable of warming and illuminating us, as well as the great or mother *Sun*, and which are in some sort its substitute.

A Table of the different Affinities observable among divers Substances, 1718.

Chemists have long since observed, that certain substances manifest a greater disposition to join or unite with some bodies than with others, still observing and subject to certain degrees or laws; for in dissolutions, where several bodies are confusedly blended together, some of these are observed to unite and adhere to one substance, with exclusion to all the rest; and what is more remarkable, if any other substance was added, which had a greater affinity with one of the two substances before united, this substance added, wou'd unite with the one, and oblige the other to quit its hold. It has likewise been further observed, that some substances seem indifferent, or at least do not manifest a greater disposition to join one substance than another; but when a

substance joins or unites with one of two substances before united, we may reasonably conclude, that such a substance has a greater affinity with that substance it so joins than the other had, which is now obliged to quit its hold.

From these observations M. Geoffroy formed the following preposition: *Whenever two substances are joined together, if a third substance, which has a greater affinity with one of the two substances so joined presents itself, this third substance will join with one and compel the other to quit its hold.*

This proposition is very extensive, and of great use in Chemistry, wherein almost every process the operator discovers those affinities, the various and often puzzling *phenomena* that occur upon the mixture of different substances, are intirely owing to this affinity between them, which were hitherto inexplicable, and wou'd still remain so, were it not for this *clue*.

But as the nature and the different degrees of those affinities are not so well known, M. Geoffroy composed the annexed table, wherein may be seen at one view, the different affinities, that occur between the principal substances, usually employed in Chemistry; by the help of this table, such as intend to apply to chemistry, might with very little trouble, soon understand the different affinities, observable

vale between those substances, the chemist employs ; *Adepts* in like manner may find their account in it ; for by it they will not only discover what happens, in the most abstruse processes, but likewise foresee what shou'd happen, upon the mixing such and such substances together.

The upper line of this table contains several substances employed in Chemistry ; immediately under each are ranged, in distinct squares, several matters compared with them, in the order of their relation to that first substance, *viz.* the nearest to the first head substance is that, which hath the greatest affinity with it, in so much that no substance standing below it, can separate those two substances asunder, on the contrary, this will separate the first head substance from any other it may be joined to, and take its place. The same is to be understood of that, which occupies the second rank in the order of affinities, *i. e.* that it will expel the first head substance from all those substances that stand below it, yielding only to that substance immediately above it, and so of all the rest.

In the first head column stands the character which denotes an acid in general ; in the square immediately under it is the mark of the *phlogiston* ; in the square under this is that of a fixed alkali ; under this that of a volatile alkali ; under this that of an absorbent earth ;
G 2
lastly,

lastly, under absorbent earths are metallic substances. The *phlogiston* is here placed immediately under acid spirits, because when once it is combined with any acid, no substance hitherto known is capable of separating or dislodging it from its acid, but on the contrary, it dislodges every other substance united to an acid, and takes its place; next to the *phlogiston*, a fixed alkali has the greatest affinity with an acid, which when once combined with it, no substance that stands below it can dislodge, but on the contrary, it expels every acid from all kinds of substances, it may be united with, and like the *phlogiston*, it takes their place; under a fixed alkali is placed a volatile alkali, which like it, dislodges an acid from every substance below it, and is only expelled by those above it; absorbent earths are placed under the volatile alkali, which like the former, attract an acid from all metallic substances, and are in their turn expelled from it only by those substances above them, in so much that an acid joined to a metallic substance, by adding an absorbent earth, this acid is separated from it*, as it is from an absorbent earth, upon the addition of a volatile alkali; here again the acid is separated from the volatile alkali, by a fixed alkali, as this is expelled by the *phlogiston* which no other substance can dislodge.

In

* We shall see hereafter an exception to this rule in the article of alum.

In the 2d head column stands the character of the marine acid, and immediately under it are ranged those different metallic substances, it has the greatest affinity with, and that in the order of their affinities, those are tin, *regulus* of antimony, copper, silver, mercury, and last of all gold, with two vacant squares between, by reason this acid is not capable of dissolving gold, without the aid of the nitrous acid *. But as metallic substances are placed in the first column in the lowest degree of affinity with acids, so we must suppose the same substances to be placed here, as in the first column, immediately after the marine acid and before tin.

In the 3d head column stands the character of the nitrous acid, and next under it, in distinct squares, the marks of those metals it has the greatest affinity with, ranged each according to the degree of that relation, *viz.* iron, copper, lead, mercury, and silver. We must here likewise suppose the substances, which in the first column stand above metallic substances to be placed here in their proper order before iron.

In the 4th column stands the vitriolic acid, and under it in separate squares, are ranged those substances, it has the greatest affinity with, in the order of that relation, *viz.* a fixed

† See before page 21.

ed alkali, a volatile alkali, and an absorbent earth, next come the metals in their order, iron, copper and silver *.

In the 5th head column hands the character of absorbent earths; as these earths have no sensible affinity but with acids, so these are ranged in separate squares according to the degree of their strength or affinity, viz, the vitriolic, the nitrous, the marine and the vegetable acid.

In the 6th head column is placed the character of a fixed alkali, and under it, as in the former the several acids ranged in the same order, and below them all sulphur; because the alkali in the composition of *hepar sulphuris* is attracted from it by any acid, the mark of the

* Experiment shews that all acids in general have a greater affinity with the *phlogiston* than with fixed alkalies. We find that the nitrous acid will quit its fixed alkaline *base* to join the *phlogiston*, and fly off with it in the process of fixing of nitre; the marine acid likewise is known to quit its fixed *basis* to join the *phlogiston* in the composition of the *phosphorus*; and as most Chemists look upon the vegetable acid to be only the mineral acid disguised, but weaker, there is sufficient grounds to think, that acids in general have a greater affinity with the *phlogiston* than with fixed alkalies; so instead of making a particular exception for the vitriolic acid, as M. *Geoffroy* did in this 4th column; it wou'd be much better to lay down this greater affinity as common to all acids whatever, and so place the *phlogiston* in the first column, immediately under acid spirits. This I have taken the liberty to do, upon M. *Macquer's* authority; I have also placed the vegetable acid under the marine acid in the columns 5, and 6, as it is, like other acids known to dissolve certain earths and metals; lastly, I have added a 17th column for ardent spirits upon M. *Macquer's* judging such a column was necessary.

the volatile fulphurious acid, might for the same reason be placed in the same square with sulphur, as it is known to have, of all acids the least affinity with a fixed alkali, so any of them may expel it; oils also might be here ranged with sulphur, as they unite with fixed alkalies in the making of soap, which is decomposed by any acid whatever*.

In the 7th head column is placed the character of a volatile alkali, and under it, as in the former column the several acids, ranged in the order of their affinities.

In the 8th head column stands the character of metallic substances, and under it the several acids ranged according to the degree of their affinities, which happens to be here somewhat different from what is observed in others, for here the marine acid is put before either the vitriolic or nitrous acid, because it is in fact found to have a greater affinity with metallic substances than either of the other acids, expelling them from all such metallic substances they may be united to, taking after their place; there may however be an exception to this, particularly with regard to iron and copper.

In the 9th head column is placed the character of sulphur, and under it those substances it has the greatest affinity with, ranged in the order of that affinity; viz. fixed alkali, iron, copper, lead, silver, *regulus* of antimony, mercury,

* Macquer, p. 165.

mercury, and gold last of all: but it is to be observed, that pure sulphur will not act upon gold, it must first become a *hepar sulphuris*, and then it will dissolve it.

In the 10th head column stands the mark for mercury, and under it several metallic substances, ranged in the order of their affinities, viz. gold, silver, lead, copper, zinc, and *regulus* of antimony.

We must here observe, that tho' mercury may, by a tedious trituration with water, be united with *regulus* of antimony, yet both spontaneously, and that in a short time separate from each other. Tin might be placed in the same square with either lead or copper, as it is found to amalgamate very well with mercury *.

The 11th head column shews that lead has a greater affinity with silver than with copper.

The 12th in like manner shews that copper has a greater affinity with mercury than with calamine.

The 13th, that silver has a greater affinity with lead than with copper.

The 14th, exhibits the affinities of iron, and under it stands *regulus* of antimony, as being the metallic substance it has the greatest affinity with.

The 15th, exhibits the affinities of *regulus* of antimony and under it iron is placed.

Note,

* Macquer, p. 166.

Note. Silver, copper and lead are placed together in the same Square in those two Columns, because the degrees of affinity of those metals with either iron or regulus of antimony are not as yet exactly known.

The 16th head column shews, that water has a greater affinity with spirit of wine than with neutral salts; for fixed alkalies, and the mineral acids, well *deflegmated*, are known to have a greater affinity with water than the spirit hath; fixed salts will imbibe what water the spirit contains, this being one method of rectifying it.

Lastly, the 17th head column shews the affinity of ardent spirits. In the next square is water, and under water is oil. This clearly shews that spirit of wine has a greater affinity with water than with oil; because any oily matter whatever, dissolved in the spirit of wine, may be actually separated from it by the affusion of water.

All this doctrine of affinities will more plainly appear, by considering the manner how corrosive sublimate is made; the Chemist for this purpose takes decrepitated salt, colcothar, or vitriol calcined, and a nitro-mercurial salt, *i. e.* solution of *mercury* in the nitrous acid, evaporated to ficcidity; when these three substances are mixed together, that instant the Chemist sensibly perceives the nitrous acid rising; and had he put this mixture into a retort, and fit-

ted a proper receiver to it, this nitrous acid wou'd come over with the least degree of fire, mixed with a small portion of the marine acid in the decrepitated salt, which becomes thereby a weak *aqua regia*, and upon increasing the fire, the mercury is found sublimed in white saline crystals; the reddish substance in the retort, by lotion in warm water, will yield a white salt, and a metallic reddish earth. What here results after the operation is very different from the substances employed; for 1st, The sea salt is a concrete salt, composed of the marine acid and an absorbent earth intimately united with it. 2dly, The *colcothar* is also a concrete salt, composed of the vitriolic acid and some particles of iron, to which the said acid is intimately united. 3dly, and lastly, The nitro-mercurial salt consists of the nitrous acid and *mercury*, closely united together. To conceive how the above changes happen, we are first to consider these three distinct substances, the marine acid, united to an absorbent earth, the vitriolic and nitrous acids united to metallic substances: Now, by the first head column of the table of affinities, all acids in general are said to have a greater affinity with absorbent earths, than with metallic substances; and by column the 5th, we see, that the vitriolic acid in particular, has a greater affinity with the *basis* of sea salt than the nitrous acid, or even the marine acid itself

self has ; from this it is evident, that the vitriolic acid (in the *colcothar*), must abandon its ferruginous *basis*, to join the *basis* of sea salt, as having a greater affinity with it, and it does so in fact ; the marine acid now dislodged from its *basis*, wou'd from its own volatile nature exhale, and fly off in vapors, did it not find some proper *matrix* to lodge in, accordingly we find by the 8th column, that the marine acid has a greater affinity with metallic substances than either the vitriolic or nitrous acid ; the marine acid in this process detaches the *mercury* from the nitrous acid, as having a greater affinity with it ; the nitrous acid now at liberty, and not finding any place to fix in, by the least degree of heat is raised in vapors, which are either red or yellow, as it happens to carry with it some portion of the marine acid. The affinity of the marine acid with *mercury* and iron, is pretty nearly the same ; but by the action of the fire, the marine acid quits the iron, the *basis* of the *colcothar*, as being too heavy to rise with it, and joins the *mercury*, which is found in white crystals, in the neck of the retort ; the *residuum* in the retort consists of the vitriolic acid, united with the *basis* of sea salt, forming with it a *sal Glauberi*, blended it is true, with a *crocus martis*, the metallic *basis* of the vitriolic acid in the *colcothar*, but no way joined to it ; for this *sal Glauberi* may be had in a dry form,

by dissolving the mass in the retort in water, filtering and evaporating it after to a certain point, and setting it in a cool place to shoot into crystals. The *crocus martis* will remain on the filter, quite deprived of its acid. By what happens in this operation, it is evident the nitrous acid is of no use in making corrosive sublimate; for it abandons the *mercury*, and flies off in vapors; and this is so true in fact, that several Chemists make corrosive sublimate without it; for by triturating together vitriol, sea salt and *mercury*, they make as good corrosive sublimate as by the former process; it must however be confessed, that the operation is more expeditious, when the *mercury* is first dissolved in the nitrous acid than when crude *mercury* is employed; for if the *mercury* is not intirely extinguished, intimately mixed with the vitriol and sea salt, the operation will not succeed; besides, the Chemist is exposed to some inconvenience from the vapors that arise, upon triturating the above substances together; likewise, when the *mercury* is dissolved in the nitrous acid, the *colcothar*, or calcined vitriol is then of no use; for by the 5th head column, the nitrous acid has a greater affinity with the *basis* of sea salt than even its own acid has, and as by the first head column, acids in general have a greater affinity with absorbent earths than with metallic substances, so the nitrous acid must necessarily abandon the *mer-*
cury

cury to join the *basis* of sea salt, as having a greater affinity with this *basis* than its own acid has. The marine acid thus dislodged from its *matrix*, and meeting with the *mercury*, now also abandoned by the nitrous acid, they both unite, and by the subsequent action of the fire, sublime to the neck of the vessel, as in the former process: in the mean time, the nitrous acid, thus expelled its *basis*, joins the *basis* of sea salt and forms with it a concrete salt, a *salt petre* of a quadrangular figure.

Others make a corrosive sublimate in still a more expeditious way; they pour on a solution of *mercury* in the nitrous acid a solution of sea salt in water, the *mercury* here precipitates, and when dried, is set to sublime as in the usual way; here again a *Salt-petre* will be found, as in the preceding process, composed of the nitrous *acid* and the *basis* of sea salt; the marine acid here likewise joins the *mercury*, and sublimes with it, as in the former processes.

Lastly, a corrosive sublimate might be made with the marine acid, gently poured on a solution of *mercury* in the nitrous acid; the *mercury* here also precipitates, as in the last process, and if immediately set to sublime, will produce as good corrosive sublimate as in any of the former processes; but if the *mercury* is suffered to remain long after it is precipitated, it will be redissolved, that is, the nitrous

trous and marine acids, by incorporating together, will form an *aqua regia*, which will dissolve anew the *mercury*; and if the whole was put into a retort, and distilled by a gradual fire, an *aqua regia* wou'd come over, and by raising the fire after, the remaining mass, composed of the marine acid and *mercury*, will sublime, as in every one of the former processes.

As the marine acid in this last process is not encumbered with its *basis*, and as by the 8th head column of the table of affinities, it has a greater affinity with metallic substances than the nitrous acid, this is therefore dislodged, and being volatile in its own nature, it comes over in its own form, with the least degree of fire, while the marine acid remains united with the *mercury* in the bottom of the retort, which upon raising the fire, sublimes as in the common, and in every other process.

Some Objections to the Table of Affinities discussed, 1720.

As the fundry substances employed in Chemistry are so many and so different, it was scarce possible to comprehend all their different combinations, and at the same time to observe their different degrees of affinity, without being liable to some objections; it has therefore been objected, 1st, That lime (which is generally considered as an absorbent earth) detaches

taches an *acid* from a fixed or volatile alkali, as is evident in the decomposition of sal ammoniac, where it is employed to separate its alkaline from its acid salt: this is contrary to the first head column of this table, where alkaline salts are said to have a greater affinity with acids than these have with absorbent earths.

M. *Geoffroy* replies to this, that lime is far from being a simple absorbent earth; all that lime has in common with absorbent earths is, that it ferments with acids; but several Chemists have looked upon lime, as a fixed alkaline salt, not unlike pot-ash, or salt of tartar; the acrid, caustic impression lime leaves on the tongue, bespeaks its alkaline Nature; for simple absorbent earths are in themselves insipid, incapable of exciting such an impression; besides, lime is known to corrode such bodies as it is applied to; which none other beside alkaline salts are observed to do; lime also dissolves all oily substances; it dissolves sulphur, when boiled with it, and gives the water a reddish colour, as all other alkaline salts are known to do; if therefore lime was a simple absorbent earth only, it cou'd never do all this; it is also well known, that lime helps the fusion of sand, and other substances in the manufacture of glass, in the same manner that all alkaline salts do, which neither chalk, nor any other absorbent earth was ever observed to do,

at

at least not till they were reduced into a *calx*.

Lime also precipitates a solution of corrosive sublimate, turns the syrup of violets, roses, and an infusion of *turnsol* green, as all alkaline salts are known to do, with only this difference, that the color of the precipitate with other alkaline salts is of an orange color, but with lime it is of a citron-color, owing probably to some earthly parts in the *lime*.

In the *analysis* of sal ammoniac, lime is known to detach its volatile alkaline salt from its *acid*, which a simple absorbent earth will never do; wherefore since absorbent earths, such as corral, crabs-eyes, even lime-stone in powder before it is calcined, are not observed to have those properties found in lime, and since lime has many of those properties, peculiar only to alkaline salts, we must necessarily admit, that lime is very different from a simple absorbent earth, and that it contains a salt, very like the alkaline fixed salts we know.

But perhaps it may be asked, whence has lime this salt? the answer is easy; it has it from the acid in the lime-stone, and which is the same, as in alum; and as an alkaline salt is no more than a concrete salt, deprived of the most part of its acid, so the lime-stone in the burning was deprived of a part only of its acid

acid, its *calx* therefore retains all the properties of a fixed alkaline salt *.

It has been further objected to the second head column, where metallic substances are said to have less affinity with acids than with absorbent earths ; yet the *flores martiales* made with the filings of steel, or *lapis hæmatitis* and sal ammoniac are known to sublime, which denotes that metallic substances has a power to detach the acid in the sal ammoniac, so as to compel it to quit its volatile *basis*.

To answer properly this objection, it is first to be considered, that there is a wide difference between metallic substances as such, and their preparations ; for metallic substances never act upon the acid in sal ammoniac ; and whenever that happens, these metallic substances have first undergone some change in their own natural form ; this is evident in the formation of iron ; the *ore* is first made into *pigs*, these are converted after into iron ; the iron *ore* in both these violent actions of the fire is almost intirely deprived of its volatile salts ; yet whenever this iron is converted into a *crocus*, either by the moisture of the air, or by water alone, either way the component parts of iron suffer a fermentation, and in it a disunion of its parts ; these parts so dis-

* Since M. Geoffroy wrote the above Memoir, M. Du Fay has discovered in lime a fixed alkaline salt, much of the same nature of the salt of *soda* or glass-wort. See hereafter p. 285.

united, and acting upon each other, change that *arangement* of their parts, so as to produce a volatile urinous salt ; if this *crocus* was distilled, a volatile urinous salt wou'd come over with a very gentle heat, arising from the putrefaction and disunion of its parts.

Now, since this *crocus* distilled alone yields a volatile urinous salt, its producing the like salt, when mixed with sal ammoniac is not a sufficient proof of its decomposing sal ammoniac, or of its acting upon its acid, consequently this objection rather confirms than makes against this table.

M. Neuman, Chemist to his *Prussian* Majesty, objects that upon mixing three parts of *minium* and one of sal ammoniac, and distilling them after, a good quantity of a volatile, penetrating, caustic, urinous salt will sublime.

He might say the same of the several *calces* of pewter, lead, and antimony, they all having the same effect on sal ammoniac ; for *minium* is no more than a *calx* of lead, become red, by being calcined in a reverberatory fire ; all these *calces* are known to contain a fixed alkaline salt, which is produced during their calcination, in the same manner that the fixed alkaline salt of wood, for example, is produced by burning it. The *calces* therefore of metals are very different from, and not to be confounded with metallic substances.

The

The great *Stahl* was well apprized of this effect of metallic substances on sal ammoniac, where in his *Specimen Beccher. Part 2d.* § 163. there speaking of the property of acids, says, *Deinde resolvit quod antenus hoc acidum (salinum nempe ammomaci salis) a volatili suo, etiam ferrum, hæmatitis, cadmia, &c. quondo ita sicca forma, & solo ignis actu cum hoc sale coagitantur.* Where he acknowledges the action of fire as the sole agent in this case, and what is still a further confirmation, in the next paragraph he owns, that volatile urinous salts precipitate metallic substances, and absorbent earths dissolved in acids, which is conformable to this table. *Ubi tamen notari meretur, illa differentia quod sal volatile talia metallica atque terrea, si illa seorsim in acido salis spiritu solvantur, ex illo spiritu præcipitet.*

The following problem proposed by *Stahl*, and its solution, will assist us greatly towards the right understanding what has been here said of this table; the problem requires “to separate the vitriolic acid from fixed alkaline salts instantly, and in the palm of the hand.”

The solution of this problem is so much the more difficult, as the vitriolic acid is known to be the *most powerful* of all acids *, for it dissolves all other acids joined to either fixed or volatile alkaline salts, and absorbent earths;

I 2

and

* What *powerfulness, activity* and *strength* in acids are, have been explained before, at p. 6, 7.

and no acid is able to dislodge it when joined to any of those substances. The salt of tartar of all the alkaline salts known has the greatest affinity with the vitriolic acid.

M. *Stahl* confess'd this, in his treatise *De Fermentatione*; *connexio acidi vitriolico-sulphurei cum alkali fixo, est quasi ultima et fatalis salino-terrea commissio, quàm purè separare, ita ut alterutrum, aut utrumque sal purum segregetur, inter postulata chimica hucusque fuit.*

This difficulty however, may be got over, and the means of procuring this separation has been before hinted *. It must be confessed, that the *phlogiston* does not oblige the salt of tartar intirely to quit the vitriolic acid, for it remains united with it in the composition of the *hepar sulphuris*, the manner of making it is thus; dissolve vitriolated tartar in a crucible placed in an open fire, adding a little alkaline salt to help its fusion; when it is dissolved, add some inflammable substance, such as powder of charcoal; the matter takes fire, and a penetrating acid vapor arises, such as common brimstone yields on burning it; upon taking the crucible out of the fire, a *hepar sulphuris* is found, composed of the salt of tartar and sulphur. Now, if this *hepar* is dissolved in water,

* The means here hinted by M. *Geoffroy* was, by placing the *phlogiston* immediately under the vitriolic acid, in the 4th column of his table; but we now know that there can be no particular exception for the vitriolic acid. See before p. 54.

ter, and filter'd, and the vegetable acid, or even a mineral acid, weakened by the addition of water be poured on it, the sulphur will precipitate; here the vitriolic acid as having a greater affinity with this *phlogiston*, than with the salt of tartar quits it, and joining the inflammable principle in the charcoal, forms with it common sulphur.

And tho' this *phlogiston* has somewhat a greater affinity with the vitriolic acid, than with the fixed alkali, yet it still has some affinity with this alkali, and retains it together with the vitriolic acid, forming therewith a *hepar sulphuris*, which like soap, becomes easily soluble in water, owing to this alkaline salt it retains; now, if this *hepar* is dissolved in water, and some of it put into the palm of the hand, and a few drops of the vegetable acid poured upon it, that instant the sulphur precipitates, which may be easily had, by gently pouring off the water, after it had settled; this is all *Stahl* required.

This artificial sulphur will yield a spirit of sulphur, by the usual method *per campanam*, which shews it contains the same acid, and an oily or inflammable matter.

M. *Stahl* in the 7th Obs. of his Chemistry, has hinted a very curious method of obtaining the same end; he there recommends to dip pieces of linen cloth in a strong *lixivium tartari*, and to suspend them after in the vapor of burning sulphur

phur, the acid contained in these vapors incorporates with the fixed alkali in the linen cloths, crusting them over with a saline *farina*; these linen cloths are steeped after in warm water, to dissolve this *farina*; the water is evaporated after to a certain point, and then set to shoot into crystals, these crystals are a true *vitriolated tartar*, with this difference only, that the vitriolic acid is here extremely rarefied, owing to the manner it is obtained, from the vapors of burning sulphur, whereas in the vitriolated tartar made in the usual way, the vitriolic acid is as highly concentrated, as it can be.

Now, to separate this vitriolic acid from its fixed alkali, dissolve this vitriolated tartar in any of the mineral acids, all which have a greater affinity with this fixed alkali, as being more concentrated than the rarefied vitriolic acid, it is here joined to; the consequence will be, that any of the mineral acids will detach this rarefied vitriolic acid, which exhales after in vapors, in the same manner the acid in sulphur exhales upon burning it in a chafing-dish.

To do the same thing in the palm of the hand; dissolve this same vitriolated tartar in water, put some of the solution into the palm of the hand, and add a few drops of the vitriolic acid to it, the vitriolic acid in the solution, being highly rarefied, will exhale in vapors, while

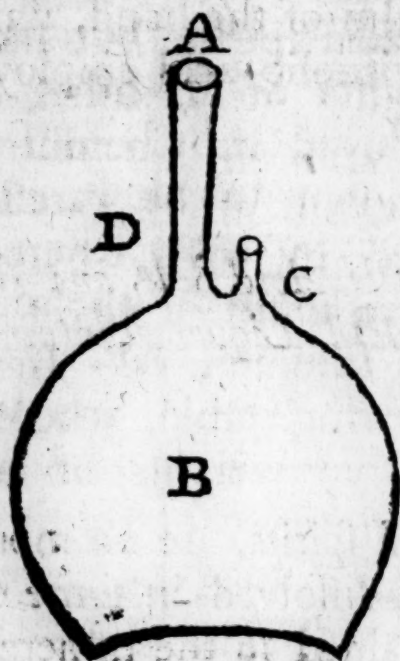
while the fixed alkali it was joined to remains with the solution in the palm of the hand, united to the concentrated vitriolic acid employed.

To discover how much volatile Acid Salt any given Quantity of an Acid Liquor contains,
1699.

What Chemists call acid spirits, are no more than the volatile acid salt dissolved in some of the *flegm* or water contained in the mineral, plant, or animal, said acid spirits were extracted from, which *flegm* cou'd never yet, by any method hitherto known, be intirely separated from them ; this often embarasses the Chemist, as he never can be certain of the strength or force of the acid spirit he employs ; because he does not know how much acid salt it contains. It is true the *areometer* will inform him how much better one acid spirit is *deflegmated* than another, but can never inform him how much volatile *acid salt* one spirit contains more than another.

As the *areometers* in common use are so defective, that the least variation in the temperature

ture of the air, as to heat and cold, are known



to produce very visible changes, M. *Homburg* has contrived one that is exempt from all the inconveniencies of all those hitherto contrived; it is so very exact, that it will shew to $\frac{1}{5}$ th or $\frac{1}{6}$ th of the weight of a drop of water, the difference in the weight of one liquor to another.

This *areometer* consists of a small glass *matrass*, whose neck A D is so slender, that one single drop of water will rise in it about half an inch; on one side of this slender neck there arises from the belly B, another small tube C, about half an inch long, of the same diameter with the neck, and parallel to it; this tube is to let out the air, as the liquor is poured in; the neck has a mark at D, to shew how high the *areometer* is to be filled; it weighs empty 1 dram 28 grs. for the conveniency of pouring in the liquor, the mouth of the *areometer* shou'd be made wide, in shape somewhat like a tundish. When this vessel is filled with any acid liquor to the mark D, the balance will shew the weight of one liquor in respect of any other, to the 5th or 6th part of the weight of one drop of water.

This

This *Areometer* not only shews the difference in the weight of acid spirits, but likewise the different weights of all other liquors, commonly employed in Chemistry; and as all liquors are known to be rarefied by heat, and condensed by cold, whereby this *areometer* will receive more of those liquors in winter than in summer, M. *Homburg* has made the following table, wherein are set down the respective weights of said liquors in summer and winter.

		Weighed in Summer.			in Winter.		
		oz.	dr.	gr.	oz.	dr.	gr.
The Areometer full of	}	11	0	7	11	0	32
Quicksilver							
Lixiv. Tartari	—	1	3	8	1	3	31
Spirit of Urine	—	1	0	32	1	0	43
Oil of Vitriol	—	1	3	58	1	4	3
The Nitrous Acid	—	1	1	40	1	1	70
The Marine Acid	—	1	0	39	1	0	47
Aqua fortis	—	1	1	38	1	1	55
Distilled Vinegar	—	0	7	55	0	7	60
Spirit of Wine	—	0	6	47	0	6	61
River Water	—	0	7	53	0	7	57
Distilled Water	—	0	7	50	0	7	54

Notwithstanding the very great exactness of this *areometer*, M. *Homburg* confesses it will never discover the quantity of acid and *flegm* contain'd in those acid liquors; to remedy this inconveniency, he has hit upon an expedient, by which he can exactly tell, how much volatile acid any given quantity of an acid liquor or spirit contains.

For this purpose, he takes the salt of tar-

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tar

tar as well dried as it can be, and after he has weighed it, he pours upon it the given acid spirit to *full saturation*; then evaporating all the moisture, and weighing it after, the increase in the weight of the salt of tartar is exactly the quantity of the volatile acid contained in the acid liquor employed *.

All this will appear more intelligible by the following table :

			Increased.		Contain'd of Volatile acid	
			dr.	gr.	dr.	gr.
An Ounce of the Salt of Tartar took up	Of the Nitrous Acid	1 2 36	3	10	2	28
	— the Marine —	2 5 0	3	14	1	15
	— Oil of Vitriol —	0 5 0	3	5	4	65
	— Aquafortis —	1 2 30	3	6	2	26
	— Distilled Vinegar	14 0 0	3	36	0	18

Before these experiments, Chemists cou'd not easily account, why an ounce of *aqua regia*, made with the nitrous acid and *sal ammoniac*, shou'd dissolve double the quantity of gold, an ounce of the marine acid equally *deflegmated* did. They were obliged to suppose that the points of the acids in the *aqua regia* were considerably harder than those

* This estimate of M. *Homburg's* is far from being accurate; for by the experiments of Drs. *Hale* and *Black*, we now know, that all fixed alkaline salts strongly attract, and are in their ordinary state, saturated with a fixed (*unelastic*) air, which must necessarily add to their weight: now, upon the admixture of an acid with a fixed alkaline salt, this fixed air is necessarily expelled; because this acid and air cannot subsist together in the same body; the alkali must therefore, lose in its weight on the avolation of its fixed air, as gain upon its being saturated with the acid, for which there is no allowance here made. See before, p. 13.

those of the marine acid, by which means it produced this double effect.

But M. *Homborg*'s experiments has satisfactorily solved this matter; one acid liquor contains double the quantity of volatile acid of the other; and as it is very well known, that all acid spirits act upon those bodies exposed to their action, in proportion to the quantity of volatile acid they contain, so whenever we find that one acid spirit dissolves double the quantity of any body or substance another acid spirit dissolves, we may with certainty conclude that that acid spirit contains double the quantity of volatile acid of the other.

M. *Homborg* conjectures that all acids, whether obtained from minerals or vegetables, are one and the same throughout all *Nature*; their sole difference consisting in the minuteness or smallness of their parts, owing to their greater or lesser division; all vegetable acids are for that reason far more volatile than the mineral acids; for the roots of vegetable substances may be properly considered as so many strainers, which continually attract from the earth this salt along with the sap; some kind of vegetables attract one kind of salt, some another, proportionable to the diameters of their several strainers or roots; this is evident upon the calcining or burning those plants, where some are found to contain salt-petre, others sea salt, others

again, a vitriolated tartar: Now, all those different salts, from the time they enter the root of the plant, shrub, or tree, 'till they come to form the flower, fruit or seed of the same, constantly undergo a greater division, as they every instant must necessarily pass from larger into narrower tubes; and it is in this greater division all their difference consists, as also why in distillation they rise sooner and with less heat than mineral acids, which have suffered no such division.

M. *Homburg* pursuing his inquiries, in order to discover the Nature of the essential salts in plants, whether they change their Nature in passing into the roots, &c. of plants, for this purpose, he took 800 weight of garden mould, and by several lotions with boiling water, endeavored to deprive it of all its salts; he divided this mould between 4 boxes; he put garden-creffes in 2 of them, and fenil-seeds in the other two; one of each boxes was watered with a solution of salt-petre in water, to the proportion of 2 ounces to each box, the other 2 boxes were watered with common water, and that only on the days it did not rain; the plants in all the 4 boxes seemed in the beginning to thrive alike; when the creffes grew to about 7 inches high, he had them taken out; he cou'd not perceive by the taste any difference between these creffes, tho' one was watered with a solu-

solution of salt-petre in water; by their *analysis* they both yielded the same principles, and nearly in the same proportion, *viz.* water, a volatile salt and an oil; and by incineration, evaporation, &c. a fix'd alkaline, or lixivial salt; both the fenil-plants were suffered to remain, till they were running to seed; they were treated in the same manner the cresses were, and yielded the same principles exactly, but in different proportions; the fenil-plant, watered with a solution of salt-petre in water, yield more of the said principles than the other; there was this remarkable in the growth of these plants; at first they all seemed to thrive alike; M. *Homborg* accounts thus for it, all plants, as well as the *embrios* of all animals, receive their first nourishment from the pulp in the plants, from the membranes, that envelope the *embrios*; while therefore this *connate* store lasts, all plants planted in the same earth must thrive alike; for then water alone is sufficient to dilute and distribute this *connate* nourishment to unfold the parts of the infant plant; but when this little *store* is consumed, the plants then depend on the earth they are planted in for their subsequent nourishment and growth; it is not therefore to be wondered, that the fenil plant, watered with *salt-petre* and water, grew taller, and throve better than its sister-plant, watered with

with river water only ; for tho' the earth can never by lotion, be totally deprived of its salts, yet it is so far deprived of all such salts as are easily soluble, of course the remaining *bitumen*, which is what gives plants, &c. their firmness is now of little use, by reason the earth has been deprived of those salts, which only are capable of attenuating and dissolving it ; it is therefore evident why those plants watered with a solution of salt-petre in water throve apace ; the salt-petre dissolved this *bitumen*, whereas river water alone, unassisted with salt, never cou'd dissolve it ; and for this reason, one of the fenil-plants, after a certain time, began to pine away and lose its color.

By this experiment it evidently appears, that some salts change their Nature, by passing into the plant along with the sap or nutritious juice, and therefore this will be always found to be true in fact, that an alkalесcent plant, plant it where you will, and water it with what salt you please, will by its *analysis*, afford no other than an alkaline salt ; whereas an аcescent plant, planted any where, will always yield an acid.

*To discover how much of the testaceous Tribe
Acids are able to dissolve, 1700.*

M. *Homberg* in the foregoing memoir, discovered how much of a volatile acid any
given

given quantity of any acid spirit contained, by employing a fixed alkaline salt; he here endeavors to discover how much of those alkaline substances employed in medicine, acid spirits are capable of dissolving, with a view to adjust more properly their dose, as well as to discover which of those alkaline substances are the easiest dissolved by our juices; for it is more than probable that the acids which certainly occasion many disorders in the human body, may resemble in their effects, some an *aqua regia*, others an *aqua fortis*; what seems to countenance this conjecture is, that some disorders will give way to absorbents only, as we observe the *lues venerea* submits to mercury, and the bite of the *viper* to volatile alkaline salts only.

Accordingly, M. Homberg took of both the nitrous and marine acids, so well *deflegmated*, as to be able to dissolve the perfect metals; the alkaline substances he employed were *crabs eyes*, *coral*, *pearl*, *mother of pearl*, *oriental* and *occidental bezoars*, *calculus humanus*, *oyster-shells*, *burnt harts-horn*, *quick* and *slack lime*, *bol of Tripoli*, *terra sigillata*, all reduced to powder. By his experiments he found that an ounce of the nitrous acid dissolved

4 drams,	9 grains of crabs eyes	} speedily.
3 drs.	7 grs. of coral	
		2 drs.

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- 2 drs. 63 grs. of pearl } speedily.
 2 drs. 58 grs. of mother of pearl }
 1 dr. 36 grs. of oriental bezoar very slowly,
 1 dr. 60 grs*. of occidental bezoar } slowly.
 2 dr. 28 grs. of the *calculus humanus* }
 3 dr. 20 gr. of oyster shell powder very speedily.
 3 drs. 28 grs. of burnt harts-horn, without
 any sensible ebullition.
 2 drs. 36 grs. of quick lime } very speedily.
 3 drs. ——— of slack lime }
 One ounce of the marine acid dissolved
 3 drs. of crabs eyes }
 2 drs. 26 grs. of coral } speedily.
 1 dr. 56 grs. of pearls }
 1 dr. 60 grs. of mother of pearl }
 46 grs. of oriental and } very slowly.
 51 grs. of occident bezoaral }
 1 dr. 24 grs. of the *calculus humanus* slowly.
 2 drs. 12 grs. of oyster-shell-powder speedily.
 2 drs. 21 grs. of burnt harts-horn, without
 any sensible ebullition.
 2 drs. 55 grs. of quick lime and } speedily.
 2 dr. 49 grs. of slack lime }
 But for the bols, neither of the acids cou'd
 dissolve them.

What is here observable is, that the nitrous acid dissolved twice more of some of these substances, and in general more of the others than the marine acid: the reason is this, the nitrous acid contains near double the quantity of salt the marine acid does. There

* The French dram contains 72 grs.

There was this remarkable in these dissolutions, that both acids dissolved the bezoars, and the *calculus humanus* slowly, tho' by their *analysis* they are known to contain a good deal of a volatile alkaline salt; M. *Homborg* conjectures this is owing to a sulphurous substance which so crusts over those animal substances as to prevent the acid from acting upon them, till by the action of the fire, in their analysis, this crusting sulphurous substance is dissolved, those same animal concretions yielded a much higher tincture to the nitrous than to the marine acid.

Both quick and slack lime dissolved equally in both acids; the only difference between them was, that the particles of fire the quick lime received in its calcination exhale, are lost on the slacking of it. Oyster-shell powder was dissolved by both acids, in both a greater quantity, as well as in a shorter time than any of the other absorbent substances; this wou'd induce one to look upon oyster-shell powder as the most useful medicine among the testaceous tribe; M. *H.* experienced the good effects of it in weak stomachs, abounding with acids; he gave it from 20 to 30 grains every morning for 3 weeks or a month in 5 or 6 spoonfuls of small white wine, or in mint water.

As this oyster-shell powder is differently prepared by the druggists, he adds his manner of preparing it; he takes the inner white part in

the under shell, which he dries in the sun ; he pounds it after in a marble mortar : it here becomes a kind of paste, he exposes it again to the sun to dry, powders it anew, and passes it thro' a fine sieve, and keeps it in bottles close corked for use.

Of cold Dissolutions, 1700.

M. Geoffroy the elder examining the several salts with a view to discover their nature and properties, has in the course of his experiments discovered two things well worthy notice ; the first is, that most salts soluble in different liquors, render them much colder, without exciting any sensible fermentation ; the second is, that notwithstanding the sensible, as well as the sudden and violent fermentation that ensues, upon mixing some certain salts with some liquors, these become sensibly colder.

M. Geoffroy has formed those dissolutions into two classes, the first comprehends those dissolutions of salts, wherein the mixture becomes considerably cold, tho' no sensible fermentation is observed ; the second contains such dissolutions as are accompanied with violent fermentations, and yet the mixture feels sensibly cold.

First Class. Of simple cold Dissolutions.

M. Geoffroy put a *Paris* pint of water into a vessel

vessel, in which he immersed a common thermometer, and left it in some time to come to the temperature of the water; after this he put 4 ounces of crude sal ammoniac into the water; the thermometer fell 2 in. 9 lin. in less than a quarter of an hour.

The same experiment made with *saltpetre*; the same thermometer fell 1 in. 3 lin.

The like experiment made with vitriol, it fell near an inch; and with common salt, it fell ten lines only.

A solution of the volatile alkaline salts had the same effect, lowering the thermometer some lines, some more, some less, as these salts happened to be more or less purified; the volatile salt of urine was observed to lower the thermometer the soonest of any.

All the lixivial or fixed alkaline salts had a contrary effect; they all warmed the water more or less, as they happened to be more or less calcined.

Sal ammoniac mix'd with the vegetable acids, such as vinegar, lemon and verjuice, gave no marks of fermentation, tho' it rendered these acid juices considerably colder, an ounce of sal ammoniac put into 4 ounces of distilled vinegar, lowered the thermometer 2 in. 3 lin. while the same salt with *lemon* and *verjuice* lowered it but 2 in. only.

Second Class. Of cold Fermentations.

Half an ounce of *saltpetre* put into 3 ounces
L 2 of

of the nitrous acid, first a good deal of vapors exhaled; the thermometer fell 4 lines.

Half an ounce of *saltpetre* put into 3 ounces of the vitriolic acid, a good deal of vapors exhaled, as in the former experiments, the thermometer fell from 6 to 7 lines.

Half an ounce of *sal ammoniac* put into 3 ounces of the nitrous acid; the thermometer fell 2 in. 5 lin. the vapors were here more considerable than what usually exhale from the nitrous acid alone.

Half an ounce of *sal ammoniac* put into 3 ounces of the oil of *vitriol*, a violent fermentation ensued; the mixture swelled considerably, a great deal of vapors exhaled, the liquor became very thick, the thermometer fell 3 in. 6 lin. what is here very remarkable, the vapors that exhaled were considerably warm, as appeared by raising the thermometer suspended in them, while the one immersed in the mixture fell considerably, giving at the same time visible signs of great cold.

Sea salt dissolved in the same acid, the mixture becomes rather warm than cold; sea salt put into its own acid, raises the thermometer a few lines, without exciting any sensible fermentation; the same salt put into oil of *vitriol* ferments with some noise, and raises a good deal of vapors; the liquor becomes like clear jelly; the thermometer rises considerably, the heat being sensible even to the

the touch. All the volatile alkalies mixed with acid spirits fermented more or less, as these happened to be more or less *deflegmated*, and the volatile alkalies were more or less purified from their fetid oils; the volatile salt of urine seemed to ferment the most of any; an ounce of this volatile salt, put into 4 ounces of distilled vinegar, fermented greatly, the mixture swelled considerably, and with noise, the thermometer fell 1 in. 9 lin.

Half an ounce of the same volatile salt of urine, put into 3 ounces of the vitriolic acid, fermented violently, the thermometer fell 2 inches 4 lines.

The mixture of the fixed alkalies with acids, becomes on the contrary very warm; all the above experiments were made with the same thermometer, and in equally cold weather.

M. *Geoffroy* to account for those appearances, supposes, with all natural philosophers, that cold consists in the diminution of motion only; the salt therefore mixed with the water, having no motion of its own, attracts a part of its motion, by which means the water becomes so much the colder as it loses of its motion; upon this supposition, it is easy to conceive, how fixed alkalies especially when well calcined, must rather warm than cool the water, by reason of the great quantity of the particles of fire, these received in their calcination; the water sets the imprisoned particles of

of fire at liberty, which of course must increate the motion of the water, *i. e.* the water must necessarily grow warm.

M. *Geoffroy* further observed, that of all the salts, sal ammoniac was the most powerful to render the water it was dissolved in cold ; this water became as cold as it is on the point of being frozen ; he happened once to dissolve a good quantity of this salt in water ; a few drops that fell from the glass vial in which the solution was made, were frozen, and even the trufs of straw, on which the vial stood, was found adhering to it, as were the drops of the solution converted into ice, tho' it was warm summer weather ; this was owing, in M. *Geoffroy's* opinion, to the very composition of sal-ammoniac ; the water dissolves easily its volatile alkali, and thereby soon loses the greatest part of its motion, and becomes the sooner cold ; while the sea salt dissolves but slowly, which helps to compleat the matter, to render the water colder, by depriving it of the little motion it still had left.

The following experiment of M. *Homburg* seems to evince the truth of this matter, he took corrosive sublimate and sal ammoniac, of each a pound, and being separately powdered, he mixed them together, and pour'd on them 3 chopins (pints) of distilled vinegar, shaking the whole well together ; the mixture became so cold, that he cou'd not hold the vessel long in his hand, tho' it was warm summer weather ;

ther ; it sometimes so happened, that employing a good quantity of the same salts, the water was turned into ice.

Here then is a much greater degree of cold than happens in a solution of sal ammoniac alone in water, by the addition of corrosive sublimate, which is not soluble in distilled vinegar ; in this case, the distilled vinegar soon dissolves the volatile alkali in the sal ammoniac, by which it loses a good deal of its motion, and meeting after with the corrosive sublimate, it enters its pores, but being unable to dissolve it, soon loses the little motion it had left, becomes fixed in part, if not in the whole, producing that sense of cold, one perceives on handling the vessel, the mixture is contained in.

How fixed alkalies mixed with acid spirits render the mixture cold, while the vapors that fly off become warm, is, upon the above supposition, easily understood ; for heat and cold in liquors are only relative qualities, depending on the greater or lesser agitation of their component parts, all owing to the particles of fire contained in their *vacuola*, or interstices ; upon the mixture of fixed alkalies with acid spirits, a great deal of vapors fly off, which contain those particles of fire, as is manifest by their feeling warm even to the touch ; we shou'd not therefore be surprized to find, that a thermometer, held suspended in such warm vapors

vapors, shou'd ascend, whilst another held in the mixture falls considerably.

The fermentation and swelling of the mixture is owing to the same particles of fire, which not being in a sufficient quantity to prevent the sudden coagulation the mixture is thrown into, are endeavoring to escape, and fly off in warm vapors, leaving the mixture so much the colder.

How common water, added to a solution of sal ammoniac in the oil of vitriol, renders the mixture warm, happens thus: the water sets at liberty the particles of fire, concentrated in the *coagulum*, that happens upon the mixture of the sal ammoniac with the oil of vitriol; if a spoonful of water is added to this mixture, the instant the fermentation is at the highest, the cold is the greatest, and the thermometer descends the lowest, the fermentation ceasing, the cold is very suddenly changed into as considerable a heat, which raises the thermometer as considerably. Oil of vitriol is known to warm water added to it.

Of the internal use of Lime-water, 1700.

Lime-water, as containing too many caustic and corrosive particles was hitherto esteemed too dangerous to be given inwardly, and was employed exteriorly only, as a drier in foul ulcers; probably it was the doctrine of acids and alkalies that first induced Physicians to give lime-

lime-water inwardly; *Willis* is the first writer that gave lime-water as a medicine.

M. *Burlet* during his residence in *Holland*, was a good deal surprized to find the *Dutch* Physicians give it, in many cases to very good purpose; he confesses, that his prejudice against lime water was owing to the observation made on the oxen, which drank of some lime water, and died of it, and those wines, which became more heady, and disorder'd those who drank of them, owing as he believed, to the lime made use of to fine them; his prejudice once removed, he began to make trials of it in several cases, both during his stay in *Holland* and after his return to *Paris*; the first he gave it to in *Holland* was to a young man, ill of a dysentery; he ordered 9 ounces a day, 3 ounces every 4 hours, mixed with as much cows milk; the flux after the second day was much abated; the stools were no longer bloody; however, on the 4th day, he vomited a good deal of viscid *flegm*, upon which he gave him a puke, and continued the lime-water for 4 days more, which intirely stopped the flux.

The second was an asthmatic man, who on the 3d day loathed it, and complained at the same time of a weight at his stomach; it was now laid aside; he ordered Alicant wine and wormwood-ale to remove the loathing and sickness of the stomach; during this time

the swelling of his legs encreased, and burst at last, which relieved his breathing; upon which he purged him, and gave him after the lime water, adding China-root, anis-feed and cinnamon in the place of the milk, which in a month intirely cured him.

M. *Burlet* after the example of *Willis* and *Morton*, gave it in some consumptive, and scrophulous cases, but to no effect; upon this he consulted the *Dutch* Phisician, who 'till then kept secret the manner he gave it in; this Phisician gave it as an alterative and pure alkaline water, capable of destroying all acid juices, the chief cause of obstructions, and most chronic disorders arising from them; he principally gave it in all *cachexies*, in the *chlorosis*, obstructions of the liver and spleen, in the scurvy, dropsy, &c. he used to mix it, one time with simple alteratives, at other times with purgatives, but more often with a tincture in great esteem in *Holland*, made of a composition of pewter, copper, and double the quantity of martial *regulus* of antimony fluxed together; this composition is powdered after, and projected into a crucible with charcoal and nitre, whereby it is converted into *scoriæ* of a pale, green color; these are reduced to a powder while yet hot, and put after into either spirit of wine, or juniper-berries; the tincture becomes of a beautiful red-color.

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The above *Dutch* Physician mixed 3 ounces of this tincture with a quart of the lime water, and gave 6 ounces a day, to both scorbutic and dropfical patients; this tincture is a great incider, and drives powerfully by urine.

A mixture made with 4 ounces of lime-water, and as much of the above tincture, an ounce of aloes in powder, and 2 drams of *crocus martis* infused for 40 hours, becomes a good medicine in the *chlorosis*, and by adding to this mixture 3 drams of the resin of jalap, it becomes a good medicine in dropfical cases; the dose is two spoonfuls every other day, either in a mess of broth, or of red cabbage juice; in rebellious quartan agues, the same lime water with a few drops of the same tincture, renders the bark more effectual.

M. *Burlet* had often observed the good effects of these mixtures in *Holland*, owing as he thinks, to the nature of the climate, which is both cold and moist, the quality of their drink, beer, and their aliments, butter, cheese and fish, on which the inhabitants chiefly live; all which contribute a good deal to render their blood thick and fizy, of course more apt to form obstructions in the capillary vessels, the constant source of most of our chronic disorders; on this account, lime water, as a powerful incider, assisted by the above active, penetrating tincture, must necessarily produce those salutary effects in all

such cases; whereas in warmer and drier climates, where the food is more succulent, the drink, wine, more spirituous, the same active medicines wou'd produce the contrary effects, stimulate the fibres too much, accelerate the circulation, and rather increase than remove the disorder: M. *Burlet* confesses that this was the effect he observed from both after his return to *Paris*; the tincture he thinks is too corrosive, and for that reason he seldom employed it, and what is more, wou'd not recommend it to any body; he looks upon it as a tincture of the reguline and sulphurous parts of antimony, attenuated by the *lixivium nitri*; he farther adds, that salt of tartar and *nitre*, calcined together, will yield the like tincture to the spirit of wine, equally as good as the former tincture in so high esteem in *Holland*. Whenever he prescribed this tincture, it was to *cachectic* and *flegmatic* patients, never mixing it with lime-water, but giving it from 50 to 60 drops, either in the patient's broth, or in some purgative draught, but in a less quantity; the best method he found in administering lime water, was mixed with either cows, asses, or goats milk, to the quantity of 8 or 9 ounces a day; where milk did not agree with the patient, he substituted a pectoral ptisan, after the manner of the great *Boyle*, to wit, saffrafras, anis-seed and liquorice root, of each 4 ounces, raisins of the sun half

half a pound, infused in 4 quarts of lime-water. The dose 4 or 5 ounces twice a day.

M. Spon in his *aphorismi novi*, p. 387, commenting upon that place in *Hippocrates*, where he recommends a lotion of lime-water for the leprosy and itch, adds, that it is an excellent vulnerary medicine, a powerful corrector of all acids and good, not only for all external ulcers, but also for internal ones, for an ulcer in the lungs, and for the dysentery, mixed with milk.

M. Burlet however confesses it is not proper for all people, some it will dry up and waste, others complain of thirst and are costive; it occasions a loathing to some, to remove which, M. Burlet was obliged to give stomachic's, as *vinum absinthites*, *theriaca*, lime-water therefore he thinks wou'd be improper in all loss of appetite, in thin, hectic habits, or costive bodies, whilst it wou'd be attended with salutary effects in all ulcers, internal or external, mixed either with milk, or with some vulnerary decoction. It stops hemorrhages, diarrhæas, dysenteries, fluor albus & ruber, and all feminal weakness, and even a gonorrhœa; it wou'd likewise be useful in all inward obstructions, tumors, provided they had not degenerated into scirbus's or cancers, and even in the King's Evil, if not too far gone; it prevents the curdling of the milk in
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the stomach, and by that means, renders the use of milk more easy to such as have weak stomachs, where milk generally disagrees; mixed with aloes, scammony, or jalap, it increases their purgative quality.

Of the Oil of Plants, 1700.

There is no plant but affords by its *analysis* a certain portion of oil; it is true, there is a wide difference in this oil, both as to quantity and quality, according to the method the artist employs to extract it; when a plant without any previous preparation is analysed, it yields less fetid oil by a brisk than by a slow fire, again, if it be an aromatic plant, it yields more essential oil, after it had fermented than before; this fetid oil never comes over till towards the end of the operation, that is, when both the acid and volatile salts are separated; so that those salts and the oil come over together; and here it has been observed, that such plants as abound with acids, and contain very little volatile salts, yield a good deal of a liquid oil; such are *melilot*, *mallows*, *self-heal*, *southern-wood*, *pimpernel*, the *sensitive plant* and others. On the other hand, such plants as contain very little of either an acid or volatile salt yield but a small quantity of a thick oil; such are the *beliotropium* of *dioscorides*, the *galega Ægyptiaca*, the *dracunculus* or *serpentaria major*, the *caltā palustris*, the

the *ambrosia maritima*, the *after conyzoides* and some others.

This observation suggested to M. *Homberg*, that acids wou'd not only promote the extraction of this oil, but purify it also; he accordingly employed distilled vinegar and the fetid oil of plants, equal parts; but as distilled vinegar contains so little acid, its effect on these thick fetid oils was very inconsiderable; he then employed a mineral acid (the marine acid), in the proportion of one of the acid to two of the oil; this oil was liquid, and from opake, it became transparent and of a deep red, as well as less *empyreumatic*, and lost one fifth of its weight; by this it appears, that the mineral acids are more capable of penetrating those fetid oils, than the vegetable; accordingly M. *H.* adds 4 ounces of the marine acid to every pound of seed, &c. and suffers them to macerate for 15 days, and distills them after by a gentle heat; this previous maceration with an acid spirit so opens and attenuates this oil, that it comes over very readily, and in a much greater quantity: M. *Homberg* obtained by this method one third more of oil, which was both transparent and smelled well, and appeared to be less *empyreumatic* than what was had by the usual process.

M. *Homberg* in another Memoir in 1701, observes, that all the *analysis* of plants, hitherto ordered to be made by the Academy, were

were made nearly in the same manner, some macerated the plants in water for some time, before they analysed them, others without any such previous maceration, proceeded to the *analysis*; the result by both processes was nearly the same, *viz.* an acid liquor, an oil, water and some earth; and what is more remarkable, the most poisonous as well as the wholesomest plants yielded the same principles; from this M. *Homberg* inferred, that tho' the principles of all plants are nearly the same, yet probably they do undergo some considerable change from the violent action of the fire, employed in their *analisis*.

M. *Homberg* to be certain of this matter, took the juice of some ripe grapes, and distilled it; what came over first was insipid, being the water of the fruit, but by degrees it became a little acid, with some signs of its containing a volatile alkaline salt; and upon encreasing the fire, a very fetid oil came over, the *residuum* in the alembic by calcination, dissolution, and evaporation, yielded a fixed alkali, and a little insipid earth.

Some of the same juice evaporated to near one third, and laid in a cool place to crystallize yielded an essential salt, a little acid; together with an oil of a pleasant taste, swimming on the top; the remaining liquor was likewise a little acid, as it still contained some of the essential salt; lastly, he set some of
this

this same juice to ferment, which soon became wine, which by distillation yielded a good deal of an inflammable spirit; the *flegm* or water came over after, the *residuum* in the alembic being evaporated to the consistence of honey, he poured on it its own spirit, after it had been well *deflegmated*, which extracted from it a fine, red oil, of an aromatic smell; in the bottom of the alembic were found crystals resembling tartar, and a little earth.

These 3 different *analyses* of the same juice yielded the same principles, but greatly altered in the first, by the violent action of the fire, in the last, by the previous fermentation; whereas these same principles suffered no change in the second *analysis* from either fire or fermentation; the sweetness of the fruit was retained in the pleasant oil, found swimming on the surface of the acid liquor, the acid taste of the same fruit remained in the essential salt, the earth remained mixed with the oil and salt, which can never be separated, without the assistance of fire, as was seen in the first *analysis*.

By all which it evidently appears, that all such *analysis*, where the violent action of fire is employed, are not so proper to discover the genuine principles and virtues of such plants, as a more gentle heat, and a previous fermentation, which assists better to separate the

natural principles that compose all such substances.

A Comparison between the Analysis of Sal ammoniac, Raw-Silk and Harts Horn, 1700.

Of all the known substances, Sal ammoniac yields, by its *analysis*, the greatest quantity of a volatile salt in a dry form, 15 ounces of sal ammoniac mixed with 20 ounces of salt of tartar, or lime, by a gentle fire yielded 10 ounces of a volatile salt in a dry form, which is two thirds of the salt employed, and three and a half ounces of a spirit, which is no more than the *flegm* contained in the salt, and which had dissolved some of the same volatile salt, and kept it extended in it. The caput mortuum weighed twenty ounces and a half, which is half an ounce more than the salt of tartar employed.

Next to sal ammoniac, harts-horn was believed to contain the greatest quantity of a volatile salt; but raw silk has been found to contain a much greater quantity; fifteen ounces of raw silk cut small, and distilled by a slow fire, yielded two ounces two drams of a volatile salt, whereas the same quantity of harts-horn, treated in the same manner, yielded but half an ounce and half a dram of the same volatile salt; both yielded a spirit, which is only some of their volatile salts extended in the
flegm,

flegm, inseparable from all substances; by this *analysis*, raw-silk contains near double the quantity of volatile salt that harts-horn does.

The long famed *guttæ anglicanæ* are no more than a spirit extracted from raw-silk, rectified with the oil of cinnamon, or some other essential aromatic oil, as Dr. *Lister* informed M. *Tournefort*. K. Charles II^d. purchased the manner of making these drops, some time after from Dr. *Goddart*; by all the experiments M. *Tournefort* cou'd make, he cou'd not perceive these drops were in any wise preferable to those made from sal ammoniac, or harts-horn, except as they are less disagreeable to the smell, they in that sense may agree better with some delicate constitutions.

Of Fermentation, 1701.

Since the doctrine of acids and alkalies was first introduced into phisic, it has been generally employed to explain all the *phenomena* observed on the mixture of divers substances.

M. *Homberg* thinks Chemists have carried this matter too far, not well considering 3 distinct actions, observable upon said mixtures; the first is fermentation, wherein after the conflict between the two substances, the sulphurous parts separate from the saline, as we daily see in the making of wine, or when two bodies are mixed together, a third results dif-

ferent from either, as in the making of all neutral salts, by adding an acid spirit, and a fixed or volatile alkali, the 2d is effevescence, wherein upon the mixing two substances, heat is produced, as happens almost always upon mixing acids with alkalies, and in the solution of most of the metallic substances in the same acids ; the third is ebullition, wherein upon the mixing certain substances together, bubbles of air are observed to rise, as happens frequently upon the solution of salts in acid spirits , what occasioned the deception was this, fermentation was often observed to produce heat, and so far it had the appearance of an effevescence, at another time, the mixture was seen to swell, and so far resembled an ebullition, but upon closer inquiry, violent effevescences are known to be produced by substances of a similar nature, between an acid and a fixed alkali, tho' there is no sulphurous matter in either ; so a simple effevescence is not always a fermentation ; again, there are some ebullitions without any heat, as when oil of vitriol is pour'd upon sal ammoniac, no heat ensues, the mixture rather grows cold, and there are effevescences without ebullition, as when the same oil of vitriol is mixed with common water ; wherefore every simple ebullition is not to be considered as an effevescence or fermentation ; the characteristic of effevescence is to produce heat,

heat, and of fermentation to produce a separation of the sulphurous and saline parts, or an union of these same parts, which has been often accompanied with a very great effervescence and flame.

Olaus Borrichius was the first who observed, that upon the mixture of an acid spirit and an essential oil, both heat and flame are produced; he instances the oil of *vitriol* and the oil of turpentine: but in order that the experiment shou'd succeed, the oil of vitriol shou'd be perfectly well *deflegmated*, and the oil of turpentine equally as well purified from its acid, that is, it shou'd be the brown thick oil, that comes at the end of the distillation of turpentine; the first oil that comes over, contains too much of the acid of the resin, which will always prevent the mineral acid's penetrating the oil, whereas the thick reddish oil contains none of this salt; when this oil is thus properly purified, the instant the acid is pour'd on it, both heat and flame are produced; why our European essential oils will not produce flame with the same mineral acids, is owing to a portion of their native acid, they still retain, which prevents the action of the oil of vitriol or the nitrous acid on them, these being the acids generally employed in making such experiments; whereas, the essential oils of *cinnamon*, *cloves*, *mace*, &c. if not adulterated with some of our European essential oils, instantly

instantly produce flame with the above mineral acids.

The *Sun* perhaps in those our colder climates is not able to raise those sulphurous parts in the same proportion into those plants, as it does in the warm, eastern regions, and for that reason, the essential oils of our European aromatic plants contain too much of their acid, which ascends with the sap into the plant, and in their distillation comes over with, and is always inseparable from their essential oil.

This sudden and violent action of those essential oils with acids, forms resinous substances, not unlike those that exude from certain trees; it is true, they do not retain the natural smell or flavor of the oil employed: the resin produced from the essential oil of cloves, and the nitrous acid, for instance, retains rather the smell of a rose; that from the oil of cinnamon and the same acid perfectly exhibits the flavor of a peach kernel when powdered; and that from the oil of mace and the same nitrous acid is like the smell of the essential oil of santals; this however, shews, that the natural resins are no more than a composition of an essential oil and an acid.

The following experiment seems to evince, that it is the marine acid, always contained in all our European essential oils, that prevents their producing flame when mixed with oil of vitriol, or the nitrous acid. M. *Homborg* added

ded as much camphor to the oil of cinnamon as it cou'd dissolve, and tho' camphor of all the known resinous substances is the most inflammable, yet in this experiment it prevented the oil of cinnamon's producing flame, when mixed with the nitrous acid; camphor is known to contain a good deal of the marine acid; this is what prevented the nitrous acid's penetrating the oil of cinnamon, as it always did, when genuine and unmixed with any other essential oil; and yet, gun-powder put into the same mixture will take fire, when the oil is consumed; the reason is this, gun-powder is neither dissolved by, nor does it dissolve the oil of cinnamon; consequently, when the mixture is consumed, the flame it excited, must necessarily set the gun-powder a fire; and now, shou'd it be asked why the same acid spirits when mixed with alkaline salts, do not produce flame? there seems to be two reasons for this; the first, when an acid and an alkali are mixed together, the acid is the only active principle, the alkali is purely passive, fit only to receive the acid; whereas when these same acid spirits are mixed with essential oils, they reciprocally act on each other, and from this mutual action, heat and flame must necessarily ensue; 2dly, All essential oils are naturally inflammable, and alkaline salts are not.

Of

Of the Volatile Salt of Plants, 1701.

M. *Homberg* continuing his *analysis* of plants, observed, that the reddish liquor, that comes over towards the end of the operation, gave manifest signs of its being both acid and alkaline, first by fermenting strongly with the marine acid, and 2dly, turning the tincture of *Tournsol* red ; and yet these neither effervesced together, nor produced the least motion, which might seem a *paradox* in Chemistry, according to the notion we have of acids and alkalies, which can never come into close contact without mutually destroying each other.

M. *Homberg* conjectures that probably it was the fetid oil, which is ever inseparable from alkaline salts, that had crufted over these salts, and so prevented the acid in the same liquor from acting upon, or penetrating it ; to discover the truth of this matter, he took two plants, one known to contain an acid, the other a volatile alkali, and distilled them separately ; he after *deflegmated* the acid liquor of the one, and purified the volatile salt of the other from its fetid oil, and saturating this volatile urinous spirit with its own volatile purified salt, he poured the above *deflegmated* acid liquor into it, but behold neither effervescence nor ebullition ensued, tho' each separately effervesced greatly, the volatile urinous spirit with the marine acid and the acid liquor, with *lixivium tartari* ; but
willing

willing to separate these salts after by distillation, he placed the alembic in a furnace, with a gentle fire under it; what came over first had a light urinous smell, but towards the end of the operation, to his great surprize, he found in the head of his alembic, a white salt in crystals, which retained a little of the urinous smell of the volatile salt; this is the first volatile *sal salsum* obtained by sublimation from plants; M. *Homberg* gave it with very good success to a lady, who had been long afflicted with pains in her kidneys; it had besides a singular effect in rendering her ever after more regular as to her *menfes*.

This salt is a kind of sal ammoniac, the vegetable acid acting here the part of the marine acid in the composition of our common sal ammoniac of the shops; the sole difference in the figure of both is, the new sal ammoniac sublimed into long, white, transparent, unctuous crystals; the common sal ammoniac sublimes into a dry, mealy, dark, white cake; besides, the new salt is but lightly acid, the common sal ammoniac is considerably so; but the chief difference is, that the new sal ammoniac is composed of two volatile salts, had from the same kind of substances, plants, the common is composed of two volatile salts, had from different substances, the one a mineral acid, the other an animal volatile alkali.

As the acid liquor employed was like distilled vinegar, and as the volatile alkali was like the volatile salt of urine, M. *Homberg* conjectured, he might produce the same kind of salt, by employing the acid of vinegar, and the spirit of urine ; accordingly he poured about six parts of distilled vinegar upon one of the spirit of urine ; neither effervescence nor ebullition ensued ; he set the mixture to distill ; what came over first had a urinous smell, as in the preceding process ; the salt likewise sublimed in white crystals ; but willing to repeat the same experiment, and not having at hand the spirit of urine, he dissolved some of the volatile dry salt of urine in river water, and poured on this solution distilled vinegar ; there presently ensued a considerable ebullition ; he kept pouring on vinegar to full *saturation* ; he set the mixture after to distill, as in the former processes ; what here came over first, had not the smell of the urinous salt, as in the preceding processes, but that of vinegar ; the salt in like manner retained the same smell of vinegar, tho' in every thing else, it was like what he had from both the preceding processes.

M. *Homberg* conjectures why this last salt retained the smell and taste of the distilled vinegar, was owing to his having fully saturated the urinous salt with the distilled vinegar, whereas
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in the former processes he employed only six parts of the acid of vinegar to one of the volatile alkali, which quantity not being sufficient to penetrate the volatile alkali, no effervescence or ebullition ensued; but when this same volatile alkali was sufficiently extended in water, the weak acid of vinegar was then able to penetrate it, and thereby raise an ebullition; it is the reverse with mineral acids, they upon their mixture with alkalies, instantly excite a very strong ebullition; for tho' M. *Homburg* is of opinion, that all acids, whether had from the mineral, vegetable or mineral Kingdoms, are one and the same thorough out all nature; yet as the *universal acid*, by ascending into the roots of the plant, continually undergoes a division, a comminution of its angles, so it necessarily must be considerably weaker than the mineral acid, which never suffered any such division, or comminution, consequently it must more powerfully penetrate any alkali, fixed or volatile, it is mixed with, and effervesce and raise an ebullition more or less violent, as it happens to be more or less *deflegmated*, and the volatile alkali is more or less purified from the fetid oil it is always joined to.

M. *Homburg* making further experiments (in 1709) relative to the strength of acids (mineral and vegetable), observed that tho' the mineral acids are considerably stronger

than the vegetable, and wou'd readily and more powerfully penetrate all volatile alkaline salts, yet he found they penetrated with great difficulty those same salts, while enveloped in their several substances; he put some of the nitrous acid to *cantharides* in power, tho' the ebullition was visible, yet it continued for upwards of two years; he observed that nearly the same wou'd happen, upon mixing the same acid with *cochineal* or the dried flesh of vipers, owing probably to the oil in those substances, which covers the volatile salt, and by that means prevents the acid's penetrating it, whereas the contrary always happens, upon the admixture of the same acid with either the urine, *serum* or gall; the ebullition is both considerable and soon over, probably because the volatile salt is here naked, not so enveloped as in the other substances.

M. *Homburg* observing the good effects of a certain preparation of *cantharides*, which was long kept a secret for the stone and gravel, under the name of *lithontripticum Tulpii*, he procured the manner of making it, which is this.

Get *cantharides* and lesser cardamon seeds freed from their husks, of each in powder a dram, rectified spirit of wine an ounce, spirit of nitre half an ounce, digest for 5 or 6 days, often shaking the bottle, leaving the cork loose
in

in it, to prevent the bursting the bottle, filter and keep for use.

The dose is from 5 to 15 or 20 drops in a glass of wine and water, in the morning, observing to take a mess of broth an hour before ; it is directed to be continued for 3 or 4 mornings.

M. *Homborg* mixing alum in powder with ox gall, happened to make a good deterfive lotion for those spots and discolorings of the face. Those spots he thinks are the saline, oily and terrene parts of the perspirable matter, which being deprived of their vehicle, stop up the mouths of the cutaneous emunctories, which from their appearance are often mistaken for worms, bred in the skin, this deterfive lotion is made thus.

Get a pound of ox-gall, half an ounce of alum in powder, beat them up together, an ebullition presently ensues, the terrene parts of of the gall and *basis* of the alum precipitate soon after, while the oily parts remain floating on the surface of the mixture ; the whole is left in digestion for 5 or 6 days ; the oil is then taken off, and the clear liquor gently decanted from the *jæces*, and put after in a vial close corked, and exposed to the sun for 3 or 4 months ; the liquor in this time becomes of a citron-color, and exhales the odor of a boiled lobster.

Half

Half an ounce of this liquor, with as much *lixivium tartari* ; and an ounce of river-water are mixed together in a bottle well corked ; as it does not keep well, a little at a time shou'd be made ; the way to use it is thus, a finger is dipt into it, and laid after on the spots, when it dries, more is laid on, repeating it 7 or 8 times a day, till the spots begin to grow red, they soon after begin to itch, and the skin to peel off for a day or two ; the spots will disappear for 5 or 6 months, if the first application shou'd not destroy them, use it a second time, which seldom fails answering the desired end.

The Analysis of a SIAMESE Cup, 1703.

This cup was found in a Gentleman's cabinet, which an embassador from *Siam* some 19 years before gave him ; as this gentleman was himself an able Chemist, he undoubtedly employed this cup in many cases, but the manner was after his death forgot, it was therefore given to M. *Homberg* to *analyse* it ; it held near 3 ounces ; probably the *Siamese* made the same use of this cup as the Europeans did of their antimonial cup. There was this singular in this cup, that it was always found covered with a yellowish powder, both on the inside and outside, tho' ever so lately washed.

M. *Hom-*

M. *Homberg* pour'd different kinds of *menstruums* on some of this cup in powder, and left them in digestion for some time; with spirit of wine, he had an orange color'd tincture; he laid one drop of this tincture on his tongue; he found the spirit had preserved its own taste, but yet had acquir'd a light smell of garlic; it being then near dinner-time, he laid it by for the time, determined to resume his experiments after dinner, but behold he no sooner sat down to table, than he complained of a *nausea*, which kept increasing, till he at length vomited with very great violence, and after dinner he had a severe colic, which held him till the next day; he complained of a weakness at his stomach for more than a month after, and whenever he eat of any meat of hard digestion, such as veal or lamb, his colic surely returned; but time and a due regimen removed it.

M. *Homberg* did not abandon his former experiments; he soon discovered this cup was composed of a red *arsenic*, much more caustic than what is in use among us; the *siamese*, and most of the eastern nations, use few other medicines but what are emetic; with this or the like cup, they make an emetic draught, which they by experience have discovered to be the only medicine able to relieve them; for in those excessive hot climates, where perspiration is very considerable, the finer parts of the blood
are

are necessarily carried off, leaving the remainder both more viscid, and harder to be moved ; a *fiamefe* therefore requires a much stronger emetic to work him than an European, we know that the dose of medicines in the torrid zone is much greater than in the more temperate ones ; a dose of *ipecacuana*, sufficient for an *Indian* wou'd kill 20 of us Europeans ; thus this red *arsenic*, which in the very smallest quantity might become a poison to us, may be no more than a gentle medicine for a *fiamefe* ; it is not impossible to render *arsenic* so as to become a safe medicine ; M. *Homberg* knew a Physician at *Rome*, who extracted from it an excellent febrifuge, which often did not excite even the least *nausea*.

The Analysis of common Sulphur, 1703.

The name of sulphur is commonly given to such bodies as contain an inflammable matter, such as brimstone, bitumens, oils, &c. and to others no way inflammable, such as the tinctures of some metals, tho' all they partake of sulphur is the color ; but as sulphur is the most active principle in all bodies, its nature shou'd be thoroughly known by the Chemist, who is so much indebted to it in the several operations he makes ; with this view M. *Homberg* analysed common sulphur, he found it is composed of an acid, an inflammable matter, an earth and a very small pittance of copper, the three
first

first are nearly in the same proportion, the metal is in so small a quantity, that it is not worth considering; the acid in sulphur is the same as in vitriol and alum, for by taking either and any oil, &c. a sulphur is composed; by saturating salt of tartar with either acid, the figure of the crystals is the same, whereas with the nitrous acid, these are quadrangular, and with the marine cubic; lastly, from the same *pyrites*, sulphur, vitriol, and alum are obtained *.

As the inflammable part of sulphur so readily catches fire, and flies off, carrying with it the acid in vapors, so it is difficult to ascertain the proportion of acid any given quantity of sulphur may contain. M. *Homburg*, by substituting a large *balloon* in the place of a common glass-bell, obtained from an ounce to an ounce and a half of acid from a pound of common brimstone.

The method he took to decompose sulphur was this, he put 4 ounces of the flowers of brimstone into a cucurbit, that wou'd contain two *Paris* pints, to which he added a pound of the distilled oil of fenik-seeds, or turpentine, the matter is left in a strong digestive heat for 8 days, during this time the flowers of brimstone are dissolved, and acquire a deep, red color; when the vessels are cold, he finds about one third of the flowers crystallized, into

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* See hereafter the note under the article of alum.

yellowish needles, he here decants the tincture, and puts it by, and adds another pound of the same oil to the above crystals, digests the matter as before, pours off by inclination the tincture, mixes it with the former, he repeats the same process 4 or 5 times, by which means all the flowers of brimstone are intirely dissolved; he puts all those several tinctures into a large bodied retort, because towards the end of the operation the matter is found to swell; by a small fire kept up for 12 or 15 days and nights about two thirds of the oil comes over colorless, together with about 4 ounces of a heavy, whitish liquor, as acid as good spirit of vitriol; there now begins to rise a reddish oil, whereupon he changes the recipient, and by gradually raising the fire for 7 or 8 hours, what of this reddish oil would rise, comes over, with more of the above whitish, acid liquor. The *caput mortuum* appears a shining, spongy, insipid mass, weighing better than 2 oz. and a half; the above reddish oil he put into another retort, and having adapted a receiver to it, by the means of a very slow fire, kept up for several days and nights, all the colorless oil, that would rise is drawn off, together with what still remained of the above acid liquor; when the oil begins to come over red, the retort is then removed from the fire, and half a pound of good spirits of wine is poured on the black, gummy substance

in

in it, the whole being well mixed together, is distilled after by a very slow fire, and more spirit added, while it retains any of the fetid odor of the mass; the spirit in this process attracts what still remained of the acid, after all the former distillations, and as it likewise deprived the matter in the retort of its fetid odor, M. *Homberg* conjectures that the insupportable smell, that accompanies those sulphurous dissolutions, is owing to this acid.

M. *Homberg* willing to know how much acid the 4 ounces of the flowers of brimstone yielded, by the several processes, he took two ounces of salt of tartar well dried, dissolved them in common water, into which he poured all the acid liquor he had saved; here a very considerable ebullition ensued, upon evaporating the solution, he found his salt of tartar had gained 3 drs. 16 grs. which he conjectures is the quantity of acid the 4 ounces of the flowers of brimstone contained, with what was inevitably lost in the operation, upon often changing the vessels, and which may amount to near as much more, so that 4 oz. of brimstone might be computed to contain about 6 drs. of acid, which is near one sixth of the whole *.

As

* This proportion of acid, said to be contained in sulphur, falls vastly short of *Neuman's*; he tells us that a pound of sulphur contains upwards of 15 oz. 6 drs. of pure vitriolic acid, void of *flegm*, the inflammable matter, by which so large a quantity

As to the earth, when washed and well dried it weighed an ounce and near a dram, which is a little more than one fourth of the whole; it wou'd not vitrify in the strongest fire, nor even when exposed in the *focus* of the burning glass, until he added a little *borax* to it, and then it vitrified and became of a greyish brown color, which after it lay for some time in a moist place, was covered with a kind of verdigrise. It was by this means he discovered, that the metal it contained, must be copper, but in so small a quantity that he never cou'd obtain it in its metallic form.

To compose common Sulphur by re-uniting its Principia, and by substituting similar Substances, to recompose Sulphur, with some Conjectures about the Formation of Metals, 1704.

The surest means to discover the Nature of any substance is undoubtedly to *analyse* it, *i. e.* to resolve it into its *principia*; the fire that *universal Agent* the Chemist employs to decompose bodies, will it is true separate those *principia*; but they become so altered as scarce to be known for the component parts of the body or substance *analysed*; but whenever the operator can *analyse* a body, *i. e.* resolve it into its *principia*, and by reuniting the same *principia* together, recompose the same body, he

city of that most corrosive acid is, in all its properties so surprizingly changed, amounting only to about a dram. See his Chem. p. 168.

he may safely conclude he has composed such a body anew; this M. *Geoffroy* did in the re-composition of common sulphur.

M. *Homberg* in the foregoing *analysis* of sulphur, found it was composed of an acid, an inflammable matter and an earth, with a very small pittance of copper.

This *analysis* of sulphur so clearly instructs us in the manner sulphur is formed in the bowels of the earth, as easily to imitate the same, either by uniting the *principia*, sulphur by its *analysis* affords, or by substituting other substances, similar to those obtained from sulphur by its *analysis*. The *universal acid* meeting with this inflammable matter every where in the bowels of the earth, soon incorporates with it, and with an alkaline earth, to be found also every where, forms that compound substance, we call sulphur.

Upon a supposition that this is nearly the manner sulphur is naturally formed, M. *Geoffroy* took the vitriolic acid, the balsam or thick oil of sulphur, obtained after M. *Homberg's* method, of each equal parts, he set them to digest for some time, he after added one part of *Lixivium Tartari*, and putting the whole mixture into a retort, and employing a strong fire, some *flegm* came over and a little oil; when the vessels were cold, he found in the retort a yellowish red substance, which when dissolved in warm water, filter'd after, he
pour'd

pour'd distilled vinegar into it, which precipitated a white powder, to all intents and purposes like common sulphur; *Lixivium Tartari* was here added to supply the place of the alkaline earth, which in the natural composition of sulphur is necessary.

Agreeable to the same principles, M. *Geoffroy* conjectured he might compose sulphur, by employing substances similar to those, sulphur by its *analysis* yielded; he therefore took the oils of vitriol and turpentine equal parts, and setting them to digest, the mixture became first warm, and red after, exhaling an agreeable odor, nearly like that of the essence of citrons; he afterwards added one part of the *Lixivium Tartari*, and by a similar process, obtained as good sulphur as before, or as the common sulphur of the shops.

M. *Geoffroy* willing to abridge the operation, by employing an open fire, took some of the same composition, *viz.* oils of vitriol and turpentine, and *Lixivium Tartari*, and first exhaling the aqueous parts, he projected this dry matter into a crucible; the mixture soon took fire, and at first exhaled the odor *Frankincense* gives upon burning; but as the matter continued burning, it soon after took that of brimstone. M. *Geoffroy* employed with the same success the acids of sulphur and alum, which shews the acid in sulphur, and in alum is the same with the vitriolic acid.

And

And here M. *Geoffroy* considering that in the above processes, by mixing an acid with a lixivial Salt, he must necessarily have produced a concrete salt, a vitriolated tartar, he imagined he might probably succeed full as well, by employing a vitriolated tartar, or any other concrete salt, composed with the vitriolic acid: he accordingly repeated the same experiments with the following concrete salts, vitriolated tartar, *Colcothar*, *Glauber's* salt, calcined alum, and any sulphurous substance, such as pit and charcoal in powder, fetid oils of plants and animals, and with every one of them composed sulphur, in every respect like the common sulphur of the shops.

He put one ounce of *colcothar* and 2 drams of salt of tartar into a crucible in an open fire, and just as the matter was ready to melt, he added by little and little an ounce of spirits of wine; the mixture immediately took fire, exhaling at the same time the odor of brimstone; when it ceased burning, he took the crucible out of the fire; he found in the bottom a yellowish red substance, which after solution, filtration, precipitated with distilled vinegar a sulphur, as in the former processes.

And here it is somewhat extraordinary that so subtile a *phlogiston*, as is contained in the spirit of wine, cou'd so suddenly incorporate with a salt in fusion in an open fire.

M. *Geof-*

M. *Geoffroy's* success in this operation suggested to him, that he may substitute any other inflammable matter in the place of the spirit of wine; accordingly with *petroleum*, oils of amber, turpentine, fetid animal oils and any of the above concrete salts, he always made common sulphur; but attempting to do the same with decripitated sea salt, and *Lixivium Nitri*, he did not succeed; he conjectures that this might be owing to some difference between the marine and vitriolic acid; however, all those experiments confirm M. *Homberg's* analysis of sulphur, viz. that it is composed of an acid, an inflammable matter and an earth.

Both *Boyle* and *Glauber* had before composed sulphur; *Boyle* employed the oils of vitriol and turpentine, which he distilled in a retort, he found in its neck, and adhering to the sides of the receiver sulphur; in this process the sulphur sublimed, because there was no lixivial salt employed, whereas M. *Geoffroy* always employed some.

Glauber employed his *sal admirabile* and powder of charcoal, which he projected into a crucible, placed in an open fire; the mixture soon takes fire, exhaling a strong smell of burning brimstone; when the matter in the crucible was dissolved in water, filtrated after, upon pouring distilled vinegar into it, a true sulphur is precipitated.

Glauber

Glauber by this process cou'd only inform us, that with his *sal admirabile* and powder of charcoal we might compose sulphur. But by *M. Geoffroy's* experiments we know the same might be done, by employing the vitriolic acid and any other oil or inflammable matter.

Glauber believed his sulphur was contained in the powder of charcoal; *Boyle* objected to this, and insisted that the sulphur both composed, was in the salt employed; but by *M. Geoffroy's* experiments, it is evident they were both mistaken; for their sulphur was not contained in the salt or oil of vitriol alone, nor in the oil of turpentine or powder of charcoal, but was the result of the combination of both, as both the *analysis* and recombination of sulphur evidently demonstrate.

From the above experiments to recombine sulphur, *M. Geoffroy* hazards this conjecture, *that probably all metals are no more than a compound of the vitriolic acid, the phlogiston, or inflammable principle and a portion of earth.* Iron he thinks, is undoubtedly composed of these *principia*; the common *crocus martis* declares as much; its being soluble in water, proves it contains salt, the impression these salts make on the tongue, leave no doubt of their being vitriolic; lastly, the promptitude with which this *crocus* takes fire, demonstrates its containing the inflammable principle; but what shou'd seem to put this matter beyond all

doubt is, that M. *Geoffroy* insists he really had composed iron ; he took common *argilla*, and having reduced it to a powder, he made small balls with it and linseed oil ; he put these balls into a retort, placed in a reverberatory furnace, where by the strongest degree of fire, a most penetrating oil came over ; the balls remaining in the retort he powdered anew, and by several lotions with water he washed away the earth, and found after on the filter a black, heavy matter, which presented to the *magnet*, proved its being iron by its adhering to it.

But as M. *Geoffroy* had some doubts with himself, that this *argilla* might contain some particles of iron, as well as the *caput mortuum*, remaining after the distillation of the oils of vitriol and turpentine, and still pursuing his inquiries, he proposed the year following this chemical problem, *whether it is possible to procure ashes, from either vegetable or animal substances, intirely free from any particles of iron.*

Of the Formation of Iron, 1705.

M. *Geoffroy* having by the preceding experiments, composed sulphur by re-uniting its *principia*, and from his success therein, advanced that iron is composed of the vitriolic acid, a sulphur and an earth, so he conjectured he might in like manner, artificially compose iron, by combining its *prinicipia*, as he had

had done those of sulphur ; but suspecting the substances he employed did actually contain some particles of iron, so with a scrupulous exactness he endeavored to procure ashes, a meer elementary earth, devoid of all salts ; he therefore took care that the wood he employed was neither sawed nor cut with any iron instrument, nor burnt on, or in any of the same metal, nor the ashes even stirred with an iron *spatula* ; he likewise had those ashes so often washed, as to deprive them of all their salts, so as nothing cou'd be supposed to remain on the filter but pure elementary earth ; yet notwithstanding all his exactness and care, he always found particles of iron in all the several kinds of ashes he procured ; and as this was always the case, he began to reflect, that those particles of iron did not actually pre-exist in the wood, plant or animal the ashes were obtained from, but must be a new production, arising from the combination of the natural *principia* of iron, the acid, the inflammable matter, and earth, contained in all plants and animals, which, during the incineration, are so united as to compose that metal we call iron ; for M. *Geoffroy* does not think it probable, that such heavy particles as those of iron, and which have so little affinity with the sap, or nutritious juice of plants, cou'd ascend with it into the root, and circulate with the same, till it forms the flower, fruit or seed of the plant ;

consequently those particles of iron, found in the ashes of all vegetable and animal substances is a new production. Shou'd this artful formation of iron prove to be true in fact, it might lead us to the discovery of the *principia* of other metals, and in that case, the *Philosopher's Stone* might cease being any longer so great a mystery.

M. *Lemery* the son happened at the same time to be employed in making experiments with iron; accordingly the year following, 1706, he concludes from all the trials he made with iron, that it is composed of a sulphur, intimately united with an earth, *intirely excluding from its composition all acids whatsoever*, and for this reason; whenever iron meets with an acid; it is then intirely dissolved, ceases to be iron, the vitriolic, nitrous and marine acid, nay, the *acidum vagum* in the air, dissolves it and reduces it to a *crocus*; this being the case, M. *Lemery* contends M. *Geoffroy*, never composed iron; for he always found iron ready made to his hand, in all the substances he employed; oil of vitriol, every body knows, contains particles of iron, so do all other oils, the *caput mortuum* of honey and *castoreum*, after it is calcined in an open fire, is found to contain particles of iron; all therefore M. *Geoffroy* did was to set those particles of iron, contained in all bodies at liberty, and to dissipate or consume their super-abundant oil, which covered
and

and concealed them; for that iron abounds in a sulphurous substance, all the experiments made, both in our furnaces and with the burning glass do evidently demonstrate, again, the particles of iron found in the ashes of both vegetable and animal substances, exposed to the same burning-glass, exhibit the same *phenomena*, the filings of steel do, which plainly proves them to be equally iron.

As to what M. Geoffroy objected, that those particles of iron are too massive, therefore too heavy to ascend with the sap into the root of the plant, and more so to circulate with the same, till the flower, fruit or seed are formed, will appear to have no weight, when we consider, that there is no ground destitute of an iron ore, easily soluble in any acid, which then becomes a concrete body, generally known by the name of vitriol; where then is the difficulty to conceive, how this concrete salt, vitriol, whose *basis* is iron, comes to penetrate and ascend with the sap, and circulate with the same in all the tubes of the plant? it is a known fact, that one grain of vitriol (which by the bye contains one fourth only of iron), when dissolved in 9216 grains of water, gives this water both a color, and taste, capable of distinguishing the presence of vitriol; this $\frac{1}{4}$ of a grain of iron must be exceedingly well divided to become sensible, both to the eye and palate in so great a quantity of water; where

where then is the absurdity to say, that this same solution of vitriol might, and does ascend with the sap, and circulate with it in all the smallest tubes of the plant? *

But shou'd it be still urged, that as the particles of iron always retain their specific gravity, so they wou'd be always too heavy to ascend with the sap, and circulate with the same, till it forms the flowers, fruit or seed, though they may be allowed to penetrate the roots of plants; in answer we desire it may be considered, that the most fixed body we know, which resists the most violent action of fire, the earth, ascends with the sap, and circulates with the same, in both the flowers, fruit or seed of all plants, we therefore must necessarily allow, that the particles of iron, soluble in any acid or fluid, are much fitter to ascend with this sap, and circulate with it, in both the flowers, fruit or seed of all plants than this fixed, inert matter, the *earth*.

But

* Are not the virtues of chalybeate waters intirely owing to a highly attenuated ferruginous *ore*, kept suspended in a pure elementary fluid, water? if this be the case, surely this same ferruginous *ore*, to obtain the desired ends must not only penetrate the infinitely small tubes of an animal body, but to evince its presence, must add a *momentum* to the impelling fluid, in order to comminute the impacted, obstructing matter, otherwise, it will not be easy to account, how chalybeate waters can even assist in the removal of several chronical maladies: where then can be the absurdity to affirm, that those particles of iron do, not only ascend with the sap, but also circulate with the same in all the tubes of the same plant; we therefore shou'd not be surprized to find particles of iron in the ashes, either of vegetable or animal substances.

But further, when we consider the great volatility of iron, how readily it sublimes into flowers, and that with a very small degree of fire, we shall the more easily conceive, how capable it is to rise with the sap, and circulate with it in the smallest tubes in a plant.

M. *Lemery* making some experiments with the filings of steel, dissolved in the nitrous acid, experienced the great volatility of iron, and at the same time hit upon as curious a vegetation of iron as M. *Homborg* has in his dissolution of silver. M. *Lemery* pour'd upon this solution of iron, some of the *lixivium tartari*; the mixture soon began to ferment, swell and rise, so as to crust over both the inside and outside of the glass the mixture was in, forming a most beautiful expansion, resembling the leaves and flowers of some of the spreading plants, such as *ivy*, the *vine*, &c.

Why those particles of iron do not become manifest till after the incineration of the plant is, because they are in too small a quantity, in proportion to the other principles, to appear in their own form; but when the fire has consumed the oil, salt and *phlegm* they are wrapped up in, they then manifest themselves, and appear in their genuine form of iron.

The good effects arising from disputes in learned assemblies, have already been taken notice of *, and perhaps were they more frequent,

* See Vol. I. p. 183.

quent, truth wou'd be the sooner discovered ; for the particular interest, each takes to support what he had advanced, both raises and enlarges his desire of coming at the truth ; we have here seen the warm disputes that arose between Mess. *Geoffroy* and *Lemery*, about the formation of iron. M. *Geoffroy* contending that an acid was a necessary component part of iron, M. *Lemery* as strenuously denying it ; for what destroys the very form and being of iron as iron, cannot with any color of argument be said to be one of its necessary, component parts ; all acids do this. M. *Lemery* goes further, and insists that all the substances M. *Geoffroy* employed to make artificial iron with, did actually contain iron. M. *Lemery* considers those substances one after the other, and first the *argilla* ; he calcined it in an open fire, the powder presented after to the *magnet* gave manifest proof of its containing particles of iron, by adhering to it ; he took likewise the oils of turpentine, linseed, olive, sweet almonds ; these he distilled to draw off their finer parts, what remained in the *cucurbit* he calcined in an open fire, powdered and presented to the *magnet*, it gave the same signs of its containing particles of iron ; and as to the oil of vitriol, every body knows it contains particles of iron ; it is therefore evident to a demonstration, that M. *Geoffroy* never composed one *atom* of iron ; all he did was to unfold and make manifest those

those particles of iron, that actually pre-existed in the *argilla*, and other substances he employed; and therefore to advance that those particles of iron, found in the ashes of all vegetable and animal substances, were a new production, made during their calcination, by the union of their acid, oil and earth, is as if he shou'd say, that iron extracted from vitriol, for example, by the action of fire, was a new production, when we very well know, that vitriol did actually contain iron, before it was exposed to the action of fire; therefore, the particles of iron, found in the one (the plant), were no more produced anew in the time of its calcination than in the other (the vitriol), during the action of the fire; the fire in both (the plant and vitriol), only dissipates the volatile parts, the sulphur or oil and the salts; the fixed part, the iron, remains in the ashes; consequently those particles of iron did actually pre-exist in both the plant and animal before their calcination.

To conclude: had not the Nature of vitriol been so well known as it is, he who upon *analysing* it, shou'd find particles of iron in the *caput mortuum*, might with as good reason say, he had composed iron, as M. Geoffroy has to say, that the particles of iron, found in the ashes of all substances were a

new production, during the time of their calcination.

How conclusive soever those arguments and experiments appeared, M. *Geoffroy* still insisted (1707), that an acid was necessary for the production of iron, and that those particles of iron, found in the ashes of all substances after their calcination, were a new production; for all plants and animals are found to contain the three necessary principles, an acid, an oil, and an earth, and all the fire does is, to unite those principles, as he had done in his former processes.

And as to what M. *Lemery* founded most his arguments on, that all the substances M. *Geoffroy* had employed, as *argilla*, oils, &c. did really contain particles of iron, is only so far true, as they do contain the above 3 principles, necessary for its production, which by the action of the fire, become so united as to produce what did not really pre-exist in them, iron; and here, if those particles of iron, found in the ashes of all plants, did really pre-exist in them, before their calcination, how comes it that those same particles of iron, said to be so subtilly divided, and mixed with so many different juices, as there are plants in which they circulate, are never found, in either their expressed juices, or in the waters distilled from them, seeing $\frac{1}{4}$ a grain of iron, dissolved in 221184 grains
of

of water, or divided into 884736 parts, still remains sensible both to the eye and palate, and with powder of galls forms a light, red color.

What M. *Geoffroy* grounds chiefly his conjectures, relating to the production of metals on is, that the component parts of all plants and metals are essentially the same, viz. an acid, an oil and an earth; consequently that Art can both decompound metals, by separating their *principia*, and recompound the same, by substituting the *principia* of plants in the place of those the fire had deprived them of; and first, the principal mineral salts are nitre, sea salt and vitriol, the same salts are found in plants; *parietaria* abounds with nitre; put upon a red coal, it fuses as nitre does.

The fixed salt of *carduus*, wormwood, kelp, and sponge are known to contain a good deal of sea salt, which crystalizes into *cubes*, and decrepitates when thrown into the fire, as sea salt is known to do; the fixed salts of most plants, when calcined to a certain point, are known to exhale an odor of sulphur, owing no doubt to the vitriolic acid in the plant, now rendered volatile by its union with the oil, or inflammable matter; we may therefore conclude the same of all the other salts of plants: for volatile salts are no more than those same fixed salts deprived of

their most maffy, earthy parts, and united with some inflammable matter; and it is very probable that thofe acid juices, had by expreffion from plants, are effentially of the fame Nature with the mineral acid; the only difference is, that thefe acid juices had been greatly divided in the plant, and intimately mixed with the fulphur or oil of the fame, which it does not eafily quit; the acid of vinegar might therefore be properly ranged among the mineral acids; the only difference lies here, the acid in the vinegar is extended in a great deal of *flegm*, and intimately united with an oil, which however might be feparated from it; a proof of this, if you difsolve copper in the acid of vinegar, feparated from its oil as well as it can be, you will have as fine blue cryftals as if the vitriolic acid had been employed; it therefore evidently appears, that the falts, in both plants and minerals, are effentially the fame, as is their fulphur; for as M. *Geoffroy* before experienced, with any oil, whether obtained from vegetable or animal fubftances, and any acid, whether vegetable or mineral, fulphur might be made *; it is this fulphur, the *phlogifton* of all bodies, that renders metals fufible and malleable, *i. e.* constitutes them metals; antimony which in its own Nature, approaches neareft to a metal, when calcined in a dark place,

* See before p. 119.

place, will cast forth blue vapors; a proof of its containing *sulphur*, and what is more, when this sulphur is consumed, it loses its metallic form, becomes a gray *calx*, and by putting it into fusion in an open fire, it becomes a *vitrum*, in the place of the metal it was before the calcination; wou'd you regenerate this *vitrum*, restore to it the sulphur it lost; add either tartar or powder of charcoal, or any other vegetable or animal oil, and it will become antimony as before.

The sulphur of antimony might be easily had, by distilling it with corrosive sublimate; this sulphur quits the metallic earth of antimony to join the *mercury* in the corrosive sublimate, and forms with it a cinnabar of antimony, while the above metallic earth, joined to the marine acid in the sublimate goes over, and forms the butter of antimony; the earth here precipitated is the powder of *Algaroth*, which if put into fusion in a crucible, becomes a *vitrum*, being totally deprived of all its sulphur; but by restoring its sulphur, it is regenerated, and becomes antimony.

By this *analysis* of antimony it appears, that it is composed of an acid, an inflammable matter, and a vitrescible earth.

Chemists divide metals into perfect and imperfect; the perfect are so called, because their component parts are so closely united that

that the action of our ordinary fire cannot separate them ; these are gold and silver. Those of the imperfect metals on the contrary are so loosely united, that the fire of our furnaces easily separates them ; these are iron, copper, lead and tin ; in these imperfect metals the *phlogiston* is very visible ; nitre will throw them all into a *fluor* ; iron seems to contain the most of this *phlogiston*, copper the next, and lead after ; but of all the imperfect metals, tin contains least of this *phlogiston*.

This same *phlogiston* becomes sensible, by burning any of the filings of these imperfect metals in the flame of a candle ; those of iron cast a sparkling, bright flame, forming as they fall, little balls half vitrified ; the filings of copper do not sparkle as those of iron, but they take fire, and cast a bluish flame ; the filings of tin burn likewise, the vapor they emit, smells like burning orpiment ; the filings of lead emit fewer vapors than those of tin, but both cast a bluish flame.

All these imperfect metals exposed to the action of fire, are readily converted into a *calx* ; they then lose their metallic form, and as readily recover it, upon adding any oil or inflammable matter to them ; *crocus martis* for example, with linseed oil, put into a crucible, placed in an open fire, is soon regenerated, becomes both fusible and malleable, these being the true characteristics of all metals ;

tals; the *calces* of the other metals may be regenerated after the same manner. These experiments clearly evince, that the *principia* of metals do not differ essentially from those of vegetables, that in both they are no more than an acid, an inflammable matter, and a vitrescible earth; this *phlogiston* is so intimately united with the other *principia* in both gold and silver, as not to be separated by the action of our ordinary fire; but when exposed in the *focus* of a large burning glass, it then becomes sensible, and exhales in blue vapors*, whereas this same *phlogiston* is but feebly united with the other *principia* in the imperfect metals, and least of all in antimony and common brimstone; and as the *calces* of all metals, when exposed to the action of an open fire, will vitrify, and may as easily be regenerated, and restored to their pristine metallic form, by adding any oil, or inflammable matter to them, so after the same manner, iron is produced, by adding linseed oil to the *argilla*; the particles of iron in the *argilla* are thereby regenerated; and cou'd we discover all the other metallic earths, they might be also converted into metals by the like process, by adding some oil to them; consequently those particles of iron, found in the ashes of both vegetable and animal substances, were there produced anew, and after

* The matter shou'd be laid on a coppel. and not on charcoal, which wou'd always supply the *phlogiston*.

ter the same manner, from the combination of the vitrescible earth, the acid, and oil of the plant or animal, which during the action of the fire, are converted into iron; the artificial production therefore of iron is both possible and true in fact.

M. *Lemery* the year following (1708) resumed the same subject, and so satisfactorily answered every objection of M. *Geoffroy's*, that it remained a given up point, that by all his processes, he never composed iron; in the first place, M. *Geoffroy* confesses *argilla* contain some particles of iron; this alone, in M. *Lemery's* opinion, shou'd convince M. *Geoffroy*, that the addition of linseed oil to *argilla*, was not the cause of this greater quantity of the particles of iron he afterwards found in it; he shou'd first prove that the linseed oil contained no particles of iron; this he never will be able to do; but what happens in this experiment is this: the oil, by the action of the fire, opens the *argilla*, and as it burns and exhales, it carries off those acids before concealed in the pores of this *argilla*; the particles of iron, pre-existing in the *argilla*, being now freed from those acids, more of them appear than wou'd otherwise without such means, for proof of this, M. *Lemery* dissolved some filings of steel in the vitriolic acid, so as to render them incapable of being attracted by the *magnet*; he

he put this solution into two crucibles, both placed in an open-fire; to the one he added linseed oil, which soon converted it into a black powder, this presented after to the magnet, gave the usual signs of its containing particles of iron, whilst the matter in the other crucible required to be put into fusion to manifest the same thing.

This process clearly proves what was often before observed, that all the oil did, both here and in M. Geoffroy's experiment, was to promote the fusion of the filings of steel, and as it exhaled, to carry off the acids in both M. Geoffroy's *argilla* and in those filings.

But further, we know how much inflammable substances contribute to calcine both metals and salts; nitre, for example, never so thorough calcines as when some such substance is employed, such as the powder of charcoal; we likewise know, that some chemical preparations become much less corrosive, by burning spirits of wine on them, and among others the *arcanum corallinum*; the spirit as it burns, carries off a good deal of the acid employed in making the *arcanum*, wherefore tho' the *argilla* did not appear to contain so many particles of iron, before the addition of the linseed-oil as after, yet M. Geoffroy could not from thence reasonably conclude, that this greater quantity of particles of iron was composed anew.

It is well known, that some *ore's* abound, some in more, and some in a less quantity of those particles of iron; but what is very singular, and here well worthy our consideration is, that those less rich *ores*, when in powder, and presented to the *magnet*, appear to contain more particles of iron than the richest *ores*; the reason is this, the rich *ore* is intimately united with sulphurous, saline and other parts, which so closely shut up its pores, as to elude all the magnetic matter's power of acting upon it, whereas in the less rich *ore*, the particles of iron are almost quite naked; the magnetic matter has therefore the greater power to act upon them.

It hence evidently appears, that tho' a substance when presented in its natural state to the *magnet*, might appear to contain but few particles of iron, yet after it had been calcined, its pores had been opened, and after the superabundant acids had exhaled and were carried off, when presented in this state to the *magnet*, if it shou'd appear to contain more particles of iron than before the operation, it cannot be reasonably inferred, that this greater quantity of particles of *iron* is a new production; and this comes exactly to M. *Geoffroy's argilla*, which before its calcination with linseed oil, manifested but few particles of iron, but a good deal after.

And

And now, to come to M. Geoffroy's objections, he desires to know how comes it that those particles of iron, dissolved in the juices of plants are not there decomposed, seeing the water alone is capable of effecting this decomposition of iron.

M. Lemery thinks it sufficient to inform M. Geoffroy, that he never pretended that the particles of iron ascended with the sap into the plant, in its metallic form, as iron, but only in the form of a concrete salt, of a vitriol; and as M. Geoffroy acknowledges that the particles of iron, contained in vitriol, are not decomposed, but do still remain particles of iron, so M. Lemery apprehends M. Geoffroy shou'd admit, that those particles of iron in that concrete salt, vitriol, which ascend with the sap into the plant, shou'd not be decomposed, but shou'd always remain particles of iron, as he confesses they remain in the vitriol.

Again, M. Geoffroy desires to know how it comes, that those particles of iron, we suppose pre-existing in the juices of plants, never manifest themselves, either by the taste, or by mixing the powder of galls with them, as we see $\frac{1}{4}$ of a grain of iron, dissolved in 12 Paris pints (221184 grains) of water visibly retains both the color and taste of iron, and with powder of Galls produces a light red color.

By this very query, M. *Geoffroy* acknowledges that the particles of iron contained in the *vitriol*, are not decomposed, but remain still iron; but to come to the point, the acid contained in the acid juices of all plants is so intimately united with the other principles, the oil and earth of all plants, as to prevent its manifesting itself, or appearing in its Natural, genuine form, even as the poignant acid, contained in sugar never appears, till it is separated from its oil, which covered it; and as to those acid juices not changing color, upon the addition of the powder of galls, contrary to what happens upon mixing the same powder with $\frac{1}{4}$ of a grain of iron, dissolved in 12 *Paris* pints of water, this is easily accounted for; the powder of galls acts as an absorbent; when therefore it is mixed with substances, that contain the vitriolic acid; it then attracts this vitriolic acid, as having a greater affinity with it than its metallic basis has, the particles of iron, now abandoned by their solvent acid, precipitate, and so change the color of the water; we cou'd not reasonably expect the same shou'd happen, when this powder of galls is mixed with those acid juices of plants, where this vegetable vitriol is so intimately united with the other principles of the plant, its oil and earth.

To

To illustrate this matter, M. *Lemery* put a solution of vitriol into three different glasses; to the 1st, he added a little *aqua fortis*, to the 2d, the marine acid, and to the 3d, the vitriolic acid; he put to every one of those solutions some of the infusion of galls, which made no kind of alteration in the color of any of them; the vitriolic acid may therefore be so enveloped, and concealed as not to exhibit any sign of its being contained in such substances, upon the adding the powder of galls; and why may not this be the case, when the same powder of galls is added to the acid juices of plants?

But further to clear up this matter, M. *Geoffroy* confesses *argilla* contains some particles of iron, he also confesses it contains a vitriolic acid; we may therefore conclude it contains vitriol, which is a composition of the vitriolic acid and iron: Now, M. *Lemery* poured an infusion of galls upon a solution of *argilla*, mixed them well together, and left them for some time in that situation; yet no change was made. Now, as the infusion of galls had no effect upon the particles of iron in the *argilla*, how cou'd M. *Geoffroy* expect the same infusion cou'd have any effect on those acid juices of plants, where probably the particles of iron are by far more encumbered with other substances than they are even in the *argilla*.

But

But further, M. *Geoffroy* confesses that the principal mineral salts, such as nitre, sea salt and vitriol are contained in plants; he must likewise confess those plants contain iron; for vitriol as vitriol necessarily bespeaks iron, whose *basis* it is, and which it ever contains, as long as it remains vitriol in M. *Geoffroy*'s own opinion: But 2dly, M. *Geoffroy* ranges the acid of vinegar among the mineral acids; now, as the acid of vinegar is obtained by distillation, by the help of fire from vegetable substances, and yet is not by him pretended to be a new production by fire, why shou'd the particles of iron, extracted from the same vegetables, be considered as the product of the same agent (fire)? this wou'd seem to involve a contradiction; for if the vitriolic acid be allowed to ascend with the sap into the plant, why shou'd not its *basis*, iron, be also allowed to ascend with the same sap, at least in the form of vitriol?

What probably happens here is this: Both the vitriolic acid and its ferruginous *basis* ascend together with the sap into the plant in the form of vitriol; when this plant comes after to be analysed, this acid and ferruginous *basis* are then disunited, and obtained separate; some thing similar to this is observable in those acid juices, obtained by expression from plants; this acid, disengaged from its ferruginous *basis*, and at liberty,
joins

joins the oil and *flegm* in the plant, to form those acid juices; all this while the ferruginous particles remain with the *fæces*, and wou'd ever remain there concealed, had not the fire dissipated what remained of the vitriolic acid, by which means those particles of iron become manifest.

This is further elucidated by considering, that neither those plants dried and reduced to powder, nor even vitriol calcined into a white or red powder, when presented to the *magnet*, exhibit any signs of their containing particles of iron, because both the vegetable and mineral vitriols, in that state, are too much encumbered and enveloped with acids, which will ever prevent the *magnet's* acting on the ferruginous particles contained in those powders; but when the fire has deprived both those vitriols of their abundant acids, then those ferruginous particles will manifest themselves in their genuine metallic form.

What happens upon the calcination of plants is pretty nearly the same; all plants abound more or less in a sulphurous, inflammable matter, as this matter burns, it carries off the abundant acids; the ferruginous particles, now freed from those acids, manifest themselves after in their ashes; but as in the *analysis* of vitriol, the particles of iron lost the best part of their native sulphur, which
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rendered them malleable, so the particles of iron in the plants, lose also their native sulphur in their calcination; consequently the particles of iron in both the vitriol and plant, are reduced to the same condition, *i. e.* become less malleable, resembling herein the ore of the magnet, tho' they still remain iron; for by all the tryals made on both by the burning-glass, the particles of iron in both are essentially the same.

Now, to restore unto those particles of iron their pristine, metallic state, their ductility, by the addition of some inflammable matter, cannot with any color of reason be called a new production of them; for tho' those particles of iron became less malleable, *i. e.* less sulphurous, yet they still remained iron, just as much as gold or silver, dissolved in their respective *menstrua*, still remain gold and silver, tho' while in that state they are no way malleable. Now, iron might lose its malleability two manner of ways, and all this while remain iron; first when it is dissolved by some acid, which will always keep its parts too far asunder, and by that means prevent their necessary union; and 2dly, when the fire has deprived it of its native sulphur or *phlogiston* the true cement of all metals, iron no longer remains malleable, *i. e.* it will no longer flatten under the hammer; but even in this state, it does not cease to be iron;

iron; for it is even now attracted by the *magnet*, which in M. *Geoffroy*'s own opinion, is sufficient to characterize it iron; why then shou'd it become less iron, by becoming less malleable, no more than a loaf of bread, which hot from the oven, is both soft and malleable (if we may be allowed the expression), by reason of the quantity of aqueous parts it then contains; but when this same loaf is kept for some time, it loses those aqueous parts, which made it soft, and easily moulded into any form, and becomes after easily reducible into a *farina*; will then any one say, that this loaf, in this dried state, ceases to be bread? no body surely can; and by parity of reason, those particles of iron, which were deprived of their native sulphur, the *cement* of all metals, by the action of fire, cannot be said to cease to be still iron; it must be first proved, that in that state they lost their essence, what constituted them iron; this M. *Geoffroy* has not hitherto been able to do; and this must confirm what M. *Lemery* in his preceding memoir advanced, that M. *Geoffroy* neither decomposed nor composed iron.

We must therefore for the present lay aside all our flattering hopes of being able artificially to compose metals.

A Natural Sal Ammoniac, 1705.

M. *Lemery* the father had given him a salt, gathered at the foot of *Mount-Vesuvius*, called by the natives a natural sal ammoniac; it was both compact and heavy, inwardly very white, of a crystalline form, wou'd not deliquiate in the air, was without smell, of a saltish, acrid taste, very like that of the sal ammoniac of the shops.

M. *Lemery* made many experiments with it; for with it and three parts of the spirit of nitre, he made as good an *aqua regia* as if he had employed the sal ammoniac of the shops; he discovered other qualities peculiar both to sal ammoniac, and common salt, nor shou'd we be surprized at it; sal ammoniac, every body knows, contains, besides a volatile alkali, common salt. M. *Lemery* looks upon this sal ammoniac to be a fossil salt, sublimed by subterraneous fires to the top of *Mount-Vesuvius*.

A further Inquiry into the Nature of this Salt.

A salt exactly like this of *Mount-Vesuvius*, is found sublimed in the cliffs of rocks, and on the walls and tops of certain huts, the inhabitants of *Mount-Taurus*, situated in the eastern part of *Persia*, raise there for that purpose; but the late experiments made with this salt of *Mount-Vesuvius*, leave no room to doubt of its being a genuine sal ammoniac, the extraordinary eruption of *Mount-Vesuvius*, that happened in 1737, supplied such quantities of this salt, as induced the Academy at *Naples*, to direct one of their members, to make the proper inquiries and experiments,

experiments, in order to discover the genuine nature of those salts; this gentleman considering, that all salts in crystallizing, constantly assume one certain, determinate figure, viz. sea salt concreting into *cubes*, vitriol into rhomboidal parallelopipedons, alum into octoëdrons, nitre into rectangular prisms on hexagonal bases, sal ammoniac elegantly resembling the branches of a tree, imagined if the salt of *Mount-Vesuvius* contained any of those salts, they wou'd appear after their crystallization; accordingly he found, that this salt in its crystallizing, left on the sides of the vessels, small parcels of crystallized salts, which viewed thro' a microscope, resembled a tree with its branches (the constant figure of sal ammoniac), on the ends of which appeared several pyramids, of an irregular figure, but very sharp pointed, and between these branches were interspersed, in some places, a group of prisms, in other places, some small *cubes*.

Whence he inferred, that the aforesaid salt was a genuine sal ammoniac, interspersed with insensible portions of nitre and sea salt. This he there tells us, coincides with the sentiments of the Royal Academy in 1705, with those of *Tho. Cornelius* in his *progymnasma de sensibus*, of *Dom. Gulielmini* in his treatise *de salibus*, of *Boerhaave* in his *Chemistry*, and with that of many other writers.

But for a further elucidation of this matter, he tells us, 1st, he mixed some of this sal ammoniac with the spirits of vitriol and salt, without producing the least fermentation; he likewise put some of it into *lixivium tartari*, but cou'd perceive no ebullition, all which do evidently prove it to be a neutral salt, 2dly, thrown on a red-coal, it did not crepitate like sea salt, but boiled and swelled, and upon evaporating it after, it dried up, 3dly, he found it more efficacious in cooling of liquors than any salt known; for it lowered the liquor in the thermometer $4\frac{1}{2}$ inches, which is 21 lines more than the sal ammoniac of the shops did in *M. Geoffroy's* experiments*, 4thly, when put round a vessel full of water cooled with snow, the water freezes and grows hard in a very short time, 5thly, mixed with

T 2

blood

* See before p. 83.

blood newly drawn, it dissolves and keeps it dissolved for 24 hours, 6thly, a solution of this salt, injected into the vein of a dog, it first produced tremors, then universal convulsions, and lastly death.

7thly and lastly, he verified M. Lemery's experiment, by making with it and spirits of nitre an *aqua regina*, equally as if he had employed the sal ammoniac of the shops. *Phil. Transf. Abr.* Vol. 8. p. 675.

These experiments must for ever establish the existence of a natural sal ammoniac; and indeed, when we consider how the *sal ammoniac* of the shops is artificially made, we shall easily conceive, how it may be naturally form'd, by the *Chemistry of Nature*, in the bowels of the earth, as all other fossil salts are formed; all that is requisite for this purpose is, to combine a *mineral volatile acid* with an *animal volatile alkali*.

Now, we know that the earth abounds every where with this mineral acid (the *Universal Acid*;) we likewise know that a great many worms, and other insects, dwell and live under, as well as on the surface of the earth; where then is the absurdity to suppose, that those worms, insects, especially those who live near *vulcanos*, are calcined by those subterraneous fires; this *Universal Acid*, meeting with those calcined animal salts under the surface of the earth, forms with them a true natural sal ammoniac, nearly in the same manner it forms a vitriol, alum, common salt, as it happens to meet with the *matrix* of the one or the other of those fossil salts.

We shall see hereafter (of alum) that the *basis* of alum, hitherto looked upon to be a calcarious earth, is either an animal or vegetable alkaline earth, produced by such subterraneous fires.

Of the different Kinds of Vitriol, 1707.

Such medicines as are used internally, cannot be too well examined; *vitriol* is one of those; there are five kinds of it in the shops, the green, which is our copperas, a light blue,

a white, a red, and a deep blue, commonly known by the name of Cypress, or Hungarian vitriol; this last is composed of the vitriolic acid, and some particles of copper; the *analysis* of all the other different kinds of vitriol, sufficiently prove they are composed of the same vitriolic acid, and some particles of iron; these only are used internally, every one of which will make ink with galls, &c. a proof of their containing particles of iron; for neither the Cypress or Hungarian vitriol, nor the vitriolic acid, will make ink with any vegetable astringent substance, such as galls, *sumach*, *ballusts*, *pomgranate peels*, &c. whereas iron dissolved in any acid, *viz.* vitriolic, nitrous, marine or vegetable, will always make ink with any vegetable astringent substance.

How these vegetable astringent substances act upon a solution of iron in any acid, M. *Lemery* conjectures is by acting the part of an absorbent, by attracting the acid, joined to the particles of iron; this acid having a greater affinity with absorbent than with metallic substances (see tab. of affinities), the ferruginous particles, now released from this acid, are dispersed in the vegetable astringent infusion they were let loose in, and are there suspended by the sulphurous parts of the same infusion; so as to form that black liquid we call ink; that it is the sulphurous parts of these vegetable infusions, that keep the particles of iron
suspended

suspended, so as to make ink, is sufficiently evinced by other vegetable substances not making ink with a solution of iron, till some such substance is added; gum-arabic being so easily soluble in water, is what is usually added to such substances, which effectually keeps suspended those particles of iron, which from their specific gravity, wou'd soon precipitate and leave the infusion as it was before the mixture.

As all our experiments shou'd ultimately tend to the discovery of the medicinal virtues of such substances, as are to be employed in medicine, so M. *Lemery's* view in the above experiments was to discover, whether such substances, as are fittest to make ink with vitriol, are also those, experience has taught us to be the most effectual to thicken our juices, brace and wind up our relaxed fibres, blunt and obtund the acrimony and *stimulus* of those four juices, weak feeble habits are troubled with; and such he found the *pomgranate peel, balusts, sumach, roses, acorns, oak leaves and bark, galls, &c.* to be; he also poured a solution of vitriol on an infusion of several purgative plants, as *sena, manna, agaric, jalap, colocynth, tobacco, black and white bellebor root*, which suffered no change or alteration, owing to these substances not containing absorbent and sulphurous particles, capable of attracting and suspending the particles of iron, always
neces-

necessary to make ink ; but in their place they abound in active salts, which produce all their known effects, by stimulating the fibres of the stomach and bowels ; whereas he found both *rhubarb*, and *myrobolans* wou'd, with the same solution of vitriol, make ink, which evidently shews that they are, not only gentle purgers, but astringents also ; which is likewise confirmed by daily experience.

This observation wou'd incline one to think, that such vegetable substances as are proper to make ink, might likewise be endued with the greatest astringent quality ; M. *Lemery* offers it only as a conjecture, which shou'd future observation confirm to be true in fact, wou'd be of the greatest importance in practice, as it wou'd assist, and guide us in the choice of such astringent medicines.

The Analysis of Cows Urine, 1707.

The urine every body knows is the serous parts of the blood, together with some of its sulphurous and saline parts, which in often circulating with the blood, it has separated and carried off with it ; the urine of all animals, on account of those salts, must be aperitive and gently purgative, and is often attended with success in recent obstructions. The urine of such animals as live intirely on grass, is the best, being a saline extract of those vegetables the animal took in for his food ; of all others,

COWS

cows urine is less acrid, by reason of all animals, the cow is the gentlest.

But even in cows, there is a choice ; a healthy, young cow is preferable to a *meagre* sickly one ; again, the urine of a cow fed on sweet herbage, is vastly preferable to that fed on garbage, withered leaves, or even on bran, oats, hay, &c. the proper season is the spring ; for then all the herbs are growing ; the urine will therefore partake the more of their medicinal virtues.

The medicinal use of urine has been long known ; the *Germans* have had it in use a long time, the Physicians of *Strasbourg* revived its use lately, the *French* took it from them, and soon after it came into great vogue, the method the *Parisians* used, was to drink 2 or 3 half pint glasses every morning, at a quarter of an hour's distance between each glass ; they took a mess of broth after the 3d glass, observing to walk gently the morning they took it ; they strained it thro' a linen rag, for cleanliness-sake ; they continued its use 10 days or longer, as they had occasion ; for it was found to be a good *hydragogue* and diuretic.

M. *Lemery*, the father gave it with success in the *jaundice*, *dropsy*, *asthma*, *gout*, *sciatic* and *hypocondriac* cases ; he advises the patient to go to the field to have it fresh, where he has nothing to hinder him ; he thinks it may do hurt in too hot weather ; it not only purges then too violently, but also occasions great thirst

thirst and heat ; but he observed it agreed then much better with fat, foggy people ; whereas it disagreed more or less with *meagre*, bilious habits, or with replete bodies ; he also wou'd advise to give some gentle purge, and even to draw some blood, especially in replete bodies, before they did begin or enter upon a course of urine drinking, such preparation being here as necessary as it is upon entering on a course of mineral waters ; thro' a neglect of such preparation, the urine wou'd often vomit, and then it wou'd not purge, in which consists its chief virtue.

M. *Lemery* in order to render urine less disagreeable to some delicate habits, distilled it ; he gave two half pint glasses of this distilled urine to a patient ; it purged him less only than the undistilled urine did.

The Analysis of Millepides, 1709.

Millepides are insects so well known as not to require a description ; they are of two kinds, the domestic and wild ; those found in vaults, under stones or wood, are larger than those found in the fields, or in the trunks of trees ; both kinds are viviparous ; the domestic *millepedes*, as containing a greater quantity of a nitrous salt, are preferable to the wild in all nephritic colics, *jaundice*, *scrophula*, *quinsies* ; by distillation they yield a volatile salt, in every respect like the volatile salt of *vipers*, which

may therefore be substituted in its place, and given in the same dose, in all such cases where that of *vipers* is given; the volatile spirit of *millepides*, is no more than some of their volatile salt, dissolved in some of their *flegm*, it has the same virtues of the volatile salt; the *Cap. Mort.* after calcination, was found to contain particles of iron, as the *Cap. Mort.* of most other animals; however, M. *Lemery* cou'd never discover any particles of iron in the *calces* of harts-horn, ivory, crabs-eyes, or oyster-shells.

The History and Analysis of the Bezoars, 1710.

The *Bezoar* is a stony-concretion, found in the stomach of the stag, and wild goat in *Persia, China, Egypt, and America*; all kinds of *bezoars* are in *layers*, and on that account it is not well possible to counterfeit them; besides, they all have a *nucleus* of one sort or other, which makes it still the more difficult to counterfeit them; some have for their *nucleus* a straw, some a pebble, gravel or kernel of some fruit, the animal eat, the *bezoars* are heavy or light, round or oblong, as their *nucleus* is of this or the other weight or figure.

Bezoars may be divided into 5 different classes; in the 1st are all the oriental and occidental *bezoars*, in the 2^d, are those of the monkey, cayman, crabs-eyes, perles, as approaching nearest to the former in their conformation

formation and virtues, in the 3d, are all fossil *bezoars*, in the 4th the *calculus humanus* of the bladder and kidney, and those of the gall-bladder, as also those found in all brutes, as they exactly resemble those in man, the 5th are those balls found in the maw of all ruminating animals, and of others, such as the wild boar, whose maw is often found crusted over with a bezoardic kind of matter; the like balls are often found in the stomachs of both cows and calves.

Bezoars are composed of several *laminæ* or layers, of a greenish or olive color, with white *striæ*, which are found to run thro' the whole *bezoar*; these layers so closely adhere to each other that on breaking one, layers of different densities and colors are seen; these layers are sometimes found to separate from each other; the same will happen, when they are considerably heated; as the *nucleus* is generally hard, the first layer over it breaks easily when put under the teeth; it is also glutinous, and tinges the *saliva* a little.

The *bezoar* shou'd be chosen of a middling size, brownish, and such as will communicate a yellow color, when rubbed on quick-lime, and a green color when rubbed on chalk.

Bezoars will not dissolve in water; if they shou'd blister, when bored with a red hot iron, it is a presumption, they have been adul-

terated with resin ; the only preparation *bezoars* want is to reduce them into an impassable powder, taking care to separate this *nucleus*, which is possessed of no virtue, and wou'd therefore only increase the bulk of the powder.

Of Gum-Lac, 1710.

Gum-lac is a composition between a *gum* and a *resin*, of a red, hard, friable substance ; what we have comes from *Malabar*, *Bengal*, and *Pegu*. It is the work of a kind of *ant* of those countries ; these *ants* feed on flowers, and as those which grow on the higher ground, are by far more beautiful than what grow on the flat grounds, and near the sea, so the *gum lac*, the former work is much more beautiful than what those *ants*, that feed on the low grounds make ; those *ants* prick the leaves of several trees that grow in those parts, and with their own, and the juices circulating in those leaves, they work this *gum-lac*, nearly in the same manner, bees are known to work the honey-comb ; those *ants* work only 8 months in the year ; the constant and heavy rains, that fall in those climates, for the other 4 months prevent their working ; the natives prepare the *gum-lac* in this manner ; they gather this gum from off the leaves, they powder it in a mortar, and dissolve it after in boiling water, this they expose to the sun, to exhale the aqueous part, a thick extract is left behind, they put
this

this into a clean linen bag, what oozes thro' this bag is transparent and in drops, this is the finest *gum-lac*; what comes after, either by strong expreffion, or by scraping with a knife, is of a darker color, of course lefs valuable.

Father *Tachard*, one of the *Jesuit* *Miffionaries* in the *East Indies*, fent the above account to *M. de la Hire*. *M. Lemery* made feveral tryals to difcover whether it was a gum, or a refin; tho' both thefe fubftances refemble greatly each other, yet they fo far differ, that the *gum* abounds in faline, and the refin in fulphurious particles.

Olive oil cou'd draw no tincture from this *gum-lac*; fpirits of wine and the etherial fpirits of turpentine cou'd extract but a dilute tincture from it; a manifef proof that it contains few refinous parts. Water on the contrary, efpecially when impregnated with either an acid or a lixivial falt, extracted a very deep tincture from it; this fufficiently evinces that *gum-lac* abounds more in falts, and on that account, *gum-lac* fhould be looked upon as a mixture between a gum and a refin.

It is to be obferved, that all the weak acids extracted a tincture from this *gum-lac*, whereas the ftronger acids of vitriol and nitre cou'd extract none *.

The

* The reason is this, thefe ftronger acids contain but very little water, which is the only *menftruum* of gums, or gummy refinous fubftances.

The Analysis of the Blood, 1712.

Since the introduction of Chemistry into medicine, since the doctrine of acids and alkalies have been employed to explain our different maladies, Physicians began to speak very familiarly of the acids of the blood, tho' no man hitherto cou'd say he found any such thing as an acid in any animal substance; on the contrary, all the *analyses* of animal substances hitherto made, seem rather to exclude than to countenance the existence of an acid in the blood; however, when we consider how most animals are nourished, the Nature of that nourishment, being chiefly vegetable substances, which are known to abound in acids, we may from *analogy* reasonably conclude, that all the salts, in those vegetable substances, are not changed in their passage from the plant to the animal, who takes them in for his nourishment; all that seems necessary for the nourishment of an animal is, to reduce the component parts of the food, plant, &c. he takes in (its oils and salt), into a fluid, or liquor, capable of filling up the tubes in the animal who takes it in, in the same manner they filled the tubes of the plant they were extracted from.

Among animals, some are *carnivorous*, and live solely on other animals; of those, some are quadrupeds, some insects, some fishes; there

there are others that live solely on herbage, and lastly some live partly on vegetables, and partly on other animals. Now, it is conformable to our reason, that the juices of an animal shou'd partake of the Nature of the aliment he takes for his food, seeing by the foregoing *hypothesis*, it suffers no other change, in its passage into the animal, than becoming fluid as it was before in the plant, and thereby becoming capable of pervading the infinitely small tubes of the animal, who receives it. We have a convincing argument of this in the flesh of the *wild-goose* of all maritime countries; their flesh manifests both by the smell and taste, what food they live on, *i. e.* fish, in so much that it is scarce eatable; the flesh of the black bird becomes purgative in autumn, because he lives in that season on the buck-thorn berries, which are only then ripe.

From all which it is more than probable, that such animals as feed on vegetables only, retain some of those acids they received with their food, which are therefore inseparable from their blood; we shou'd then expect, that the *analysis* of such animals wou'd yield an acid, in every thing the same, the plant the animal received its nourishment from, wou'd yield by the like *analysis*.

How probable soever this consequence doth appear, yet hitherto nobody cou'd produce an
acid

acid from any animal substance; the reason is this, the acid in all vegetable substances, is joined to a fix'd alkali, which it quits in its passage, in becoming the substance or food of the animal where it meets with a volatile alkali, and with it forms a concrete salt, which is neither acid nor alkali; when therefore any animal substance is analysed, this volatile alkali, by the most gentle fire comes over, and affords the usual signs of its being an alkaline salt, by fermenting with acid liquors; the acid remains all this while behind; but upon raising the fire to the highest degree, it is forced over, where meeting in the receiver its former alkaline *basis*, it joins it anew, at least in part, and so is in a great measure disguised, for it will now ferment with the marine acid, and turn an infusion of *turnsol* red, which is contrary to our notion of acids and alkalies; but here is the *clue* to unravel all this mystery.

All the volatile alkali that came over by the first gentle heat, was not fully saturated by the acid, that by the utmost torture of fire was afterwards forced over; by this means a portion of both remain unmixed in the vehicle, in that reddish liquor in the receiver; when therefore any acid is poured on a part of this reddish liquor, an effervescence ensues between that portion of the volatile alkali, not saturated with its own acid, and the acid pour'd on it;

it; again, when a part of the same reddish liquor is pour'd on an infusion of *turnsol*, the acid, not taken up by the volatile alkali, but remaining naked in the same vehicle, in the above reddish liquor, it affords all the signs of its being an acid, by turning said infusion red; by not duly attending to this, all the *analysis* hitherto made of animal substances, were looked upon to contain no other than a volatile alkali, which always fermented with an acid.

M. *Homberg* took 13 lb. of lambs blood, and as much of sheep's blood, which he evaporated to 6 lb. he distilled it after by a gentle fire; both yielded nearly the same principles; *viz.* 5 lb. of an insipid water, the *residuum* in the retort, by the utmost torture of fire, yielded about half a pound, one half a fetid oil, the other a reddish liquor, which gave equal signs of its being both acid and alkaline; for it fermented with the marine acid, and turned the infusion of *turnsol* red; the *cap. mort.* weighed 5 ounces.

He distilled the like quantity of a calf and ox's blood; the result was nearly the same; the only observable difference was, that the blood of all young animals seemed to contain more of the above reddish liquor than the blood of older animals of the same species; this is directly *analagous* to what we find in the *analysis* of fruit; all unripe fruit are known to

contain more of this acid than the same fruit when ripe; and *è contra*, the ripe fruit is found to contain more sulphur than the unripe fruit.

From these experiments M. *Homborg* began to consider, that the blood wou'd never part with its acid, or to speak more intelligibly, that he never cou'd obtain this acid alone, 'till he had employed some third substance, capable of retaining this volatile alkali the acid is joined to in the blood; for this is exactly the case in the *analyses*, of sea salt and nitre, where, without employing some such additament, to retain the *basis* of those salts, very little of an acid will be had from them; he here considered, that there is no earth, but what contains an acid, which wou'd always render the experiment dubious; he therefore took the *cap. mort.* of the preceding processes, powdered it, and mixed it with 4 lb. of human blood, well *deflegmated*, which he distilled in a retort, first by a slow fire, to send over the aqueous parts, and raising the fire after to the highest degree, he had as much from these 4 as from 6 lb. without such means; he rectified the reddish liquor in the receiver by adding a good deal of water to it, and filtering it after thro' paper, to separate its fetid oil, and distilled it after, to draw off the water he added; he had remaining two ounces of a liquor, which was as acid as so much distilled vinegar.

M.

M. *Homberg* distilled, after the same manner, the flesh of the wolf and pike, as carnivorous animals, that of the sheep and ox, as animals that feed on herbage only; and that of the wild duck and swine, which indifferently eat of every thing, vegetable or animal; the result was nearly the same; all the difference was, that the above reddish liquor was a little more acid in the one than in the other; from all which it sufficiently appears, that the acid, contained in the aliment or food, an animal takes in, remains unaltered in his flesh and blood, and consequently the same acid will be found in the *analysis* of such animals.

Q. E. D.

M. *Homberg* pursuing his inquiries, in a second memoir read the same year, informs us that he made further experiments with the flesh of several animals, fishes and insects, and the *faeces* of animals, from all which he extracted the same kind of acid liquor; he further observes that the flesh of all the reptile kind of animals and insects, contain this acid liquor in a far greater proportion than the flesh of the greater animals, whether human or brute; for viper's flesh, whether just killed, or after they were dead and rotten, yielded by their *analysis* this acid liquor, the common field snail yielded as much as the viper, and the common fly more than either the viper or snail, or even the Spanish-fly, and the ant still

more than the common fly. This reddish acid liquor after it was rectified, and separated from its fetid oil, tasted like distilled vinegar; mixed with a solution of vitriol in water, it gave it the color of Burgundy, which evidently shews, that it contains a good deal of an acid; but no substance afforded so much of this acid liquor as the ant.

M. *Homborg* made the same experiments with cows, goats, and asses milk, all which yielded more of this reddish, acid liquor than either the flesh or blood of the same animals did, but no volatile salt; the reason is this, the milk of any animal is little else than the chyle of the same, just separated from the blood; it therefore cou'd suffer no great alteration from the time it was mixed with the blood, and may therefore be well considered as the juice only of the plant, the animal had taken for his nourishment, and not an animal juice; it therefore contained all the native salts of the plant.

There was this remarkable in the *analysis* of milk, from the above 3 animals, the water from both cows and goats milk had an agreeable smell, and even the acid liquor had not that strong *empyreuma* it had in the other *analyses*, but smelled rather like a new-buttered cake, whereas the water from the asses milk was both insipid and disagreeable, and in a short time smelled as strong as rancid lard
thrown

thrown on the fire wou'd ; all this is owing to the Nature of the milk in the said animals ; cows and goats milk contain nearly equal parts of caseous and buttyrous parts, whereas asses milk contains near four times more caseous than buttyrous parts ; and as new cheese put on the fire, exhales an insipid, disagreeable smell, so asses milk, as containing four times more of this caseous matter than either cows or goats milk, must necessarily yield a more insipid and disagreeable water in its *analysis*.

M. *Homberg* happened to procure a sufficient quantity of the *sudor humanus* from a person, who had taken a certain *Quack-medicine*, which raised so considerable a sweat, as to supply a pound every 24 hours, and that for many days successively, by wringing the sheets and linen he lay in ; this *sudor* smelled like four whey ; rubbed on blue paper, it struck a feeble red color, and nearly the same with an infusion of *turnsol* ; this *sudor* by its *analysis* yielded the same reddish, acid liquor, as all other animal substances did ; this here was a little brackish, but struck a beautiful red with the infusion of *turnsol*.

M. *Homberg* had the curiosity to examine this *Quack-medicine* ; to the eye it was of an orange color, which plainly shewed it contained sulphur ; M. *Homberg* discovered *litharge* also in it ; the manner of using it was thus ; the person warmed both his hands ; he had

had after 12 or 15 grains of this powder put into one of his hands with 3 or 4 drops of olive oil, rubbing after both his hands together for about 8 minutes, in which time the powder was worked into the pores of his hands; this operation was repeated for many days successively, and sometimes twice a day; it raised a periodic sweat, or a flow of urine, which wou'd continue for many days, even after the medicine was laid aside; some were the worse, and others received benefit from it; M. *Homburg* is of opinion, had the compounder been better acquainted with the *animal œconomy*, he might very possibly discover in what circumstances it might with safety and success be employed; this is a method of introducing preparations of lead into the body, as we do crude mercury by unction. *

M. *Homburg*

* The many and surprizing cures performed lately by M. *Goulard*, head Surgeon of the Military Hospital at *Montpelier*, by a simple preparation of *lead*, induced me to give here an extract of his book, the more so, as it is very little known among us. This medicine is no more than a tincture of *lead* in vinegar. The Author directs to put to every *Paris* pint of the best white-wine vinegar a pound of litharge of gold, to boil it after in a tinned copper pan for an hour and a quarter, constantly stirring the matter with a wooden *spatula*, then to take off the pan, and when the matter has subsided, gently to pour off by inclination the tincture, to be kept in bottles close corked for use. †—By variously combining this tincture with other things, several valuable medicines are formed, eminently superior to any now in use, for the same purposes, such as *lotions*, *cerates*, *cataplasms*, *resolutive unguents* and *plasters*, *cerecloths*, &c. in short, there is no surgical case, but where it is attended with very extraordinary success, and first, the lotion is a specific in all external inflammations,

† A lb. of Litharge will saturate 4 times this quantity of vinegar, which might have its use in Hospitals.

M. Homberg distilled urine both fresh made and after it stood to putrefy; the first gave ve-

ry
ons, and in a more especial manner, in an ophthalmy, where emollient *fotus's*, heretofore too much depended on, rather increase the evil; for by relaxing the lymphatic arteries of the *conjunctiva*, more blood is derived on them, in a time given, the distension and pain must necessarily be increased. It is employed with success to wash all simple gun-shot, and other wounds, and by dipping the dressings in the same, it prevents an inflammation of the part.

The Author has long experienced its superior virtues in all old, foul, serpiginous, cancerous, scrophulous and fistulous ulcers; no medicine so speedily resolves all callous lips, or dries up old ulcers of 20, 25, 40 years standing, without the least inconvenience from drying up those (hitherto looked upon as necessary) issues.—He has with amazing success, employed this lotion in many other external ailments, such as contusions, inflammatory tumors, erysipelas, punctures of the tendons, excoriations, burns, chilblanes, all cutaneous affections, &c. nor is it less beneficial in gouty, rheumatic and sciatic aches, applied warm as a *fotus*, repeating it twice a day or oftener, as the urgency of the symptoms may require, lapping round the part the cerecloth, and over all a warm napkin.—It is no less effectually given as a gargle in the quinsy, and all other inflammations of the *imæ fauces*, even when the parts seem threatened with a gangrene, touching the parts often with an armed-probe, dipped in the plain tincture, and gargling after with the lotion blood-warm.—The Cerate more effectually deterges, and consolidates after all kinds of ulcers than any other now in use.—The Cataplasim surprizingly resolves all scirrhus and inflammatory tumors, occult cancers wonderfully relieving the exquisite pain, that frequently accompanies such cases, and yet it is found to promote a suppuration; notwithstanding it is exempt from the many evils, consequent on those in use, such as generating fungous excrescences, callous lips, &c.—The *pomatum* very speedily dries up all tetters and other cutaneous eruptions, first observing to wash the part with the lotion blood-warm.—The Unguent has been found to resolve *anchyloses*, contractions of the tendons and nerves, &c.

The *lotion* is made by mixing a good tea-spoonfull of the *saturine* tincture, and two of brandy with a quart of common water;

ry few signs of its containing any acid, but the putrefied urine yielded, first its volatile salt,

water; —this may be rendered more or less active, by increasing or diminishing the quantity of the tincture, according to its effects, or the greater or lesser sensibility of the part it is applied to.

The *Cerate* is made by melting 4 oz. of bees-wax in a pound of olive oil, gently stirring them with a wooden spatula, the pan being taken off the fire, 4 oz. of the saturnine tincture mixed with 6 lb. of fair water is added by little and little before the matter is quite cold, and strongly work'd together, 'till the whole is incorporated; this quantity of wax is found sometimes to absorb from 8 to 9 lb. of water.

The *cataplasma*. Take crums of bread q. s. add as much of the *lotion* as will, by boiling for a few minutes, make it into a Cataplasma.

The *pomatum*. Take 8 oz. of bees-wax, 18 oz. of oil of Roses, melt over a gentle fire, add 4 oz. of the saturnine tincture, mix them well together, lastly, add a dr. of camphor, incorporate the whole well together.

The *unguent* for *anchyloses*, &c. put 2 oz. of the saturnine tincture, with two quarts of common water into an earthen glazed pipkin, placed over a gentle fire, add 18 oz. of common soap sliced, keep constantly stirring the matter till the soap is dissolved, then add a dr. of camphor, keep stirring till the whole is incorporated; —when you use it, remember to stupe and rub the part after with the *lotion*, rendered pretty warm, cover it after with a warm napkin, in about an hour after, rub in 2 or 3 drs. of the *unguent*, covering the part with soft whited-brown paper, and over all a warm napkin; repeat the same once a day, which generally in 15 or 20 days compleats a cure.

The *cerecloth* is made, by melting 12 lb. of bees-wax in $3\frac{1}{2}$ lb. of olive oil, when all is melted, add by little and little 8 oz. of the saturnine tincture, stirring the whole 'till incorporated, adding towards the end 2 drs. of camphor; the pan being taken off the fire, before the matter is cold, dip into it pieces of middling fine linen, which you may after cut into such forms as you shall have occasion for.

The *plaster*. Melt common red lead plaster and simple diachylon, ana, q. v. add vinegar q. s. to form into a mass for a plaster.

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salt, its *flegm* came over after, and by raising the fire, a reddish, acid liquor, which turn'd an infusion of *turnsol* of a bright red color; the fixed salt of urine, whether fresh made,

The *saturnine tincture* without any mixture, has been long experienced to be a sovereign medicine, not only to keep down luxuriant flesh, and resolve all callous lips, but also to check every disposition to a gangrene, nor is it less powerful to take off warts, and all other such excrescences: His method is this, he dips a probe armed with dry lint into this tincture, with which he now and again touches the bottom and lips of the ulcer; the warts, &c. he treats in the same manner, laying over them pledgets dipt in the lotion, and over all, the cerecloth and proper bandages; two oz. of the same tincture, an oz. of alum in powder and 4 or 5 spoonfuls of vinegar, mixed with a quart of French white wine make a most potent gargarism to stop those hemorrhages of the *imæ fauces*, where neither compression, ligature, nor any other topic cou'd reach.

The *lotion for the itch*. Take of the saturnine tincture and brandy, of each an oz. a *Paris* pint of common water, mix for use. The method of using it is this, the patient is to wash all the parts affected, morning and evening, before the fire in winter or in cold weather, observing to go into bed after each lotion, for as the most visible effect of this medicine is to excite a copious perspiration, so warmth in bed is known to promote it: this lotion is repeated 4 or 5 days, by which time a quart of the mixture may be employed, or more, according to the quantity of the eruption; here it often happens that the eruption rather increases for the first 4 days; this shou'd seem to evince an inciding quality in saturnine preparations, whereas all antiquity believed them possessed of a repellent one; this method of treating the itch, I find, is followed, not only in the hospitals in France, but also in private practice, which shou'd it answer with us, wou'd be a valuable discovery, the more so as it does not even sully the patients linen, or require any confinement, or particular regimen of diet; all that is necessary is to bleed and purge before it is employed.

The *bougie*. To every pd. of melted wax add $\frac{1}{2}$ oz. of the tincture; before the matter is quite cold, dip a piece of muslin, cambric or holland 9 inches broad and $2\frac{1}{2}$ feet long; cut this after into narrow oblique strips, so as the end to be introduced be the smallest, roll them first between the fingers, and after between 2 pieces of marble, to give them their proper firmness.

or after it stood a while, was a concrete salt, which distilled as we do common salt, yielded a strong marine acid.

M. *Homborg* analysed also the excrements of several animals, and particularly the *stercus humanum*, with a view, as he tells us in his Memoir of 1711, to extract a fine clear oil, as transparent as fountain water, which was believed capable of *fixing quicksilver*, i. e. converting it into silver; but he never cou'd obtain any such oil from it; but as to an acid, it yielded a little, that of a dog yielded none, herein resembling the human urine fresh, which afforded no acid, 'till it putrefied. M. *H.* thinks had he suffered this to ferment, it wou'd then, like human urine, yield an acid; horses, ashes, and hens dung yielded a little more than cows dung; goats and sheep's dung afforded a good deal more, but pigeons dung yielded more of this acid than any other animal excrement.

These experiments evidently prove that the acid in the aliments the animals take for their food, remains unaltered in their flesh and blood, while the superfluous parts go off with their excrements, without suffering any notable change.

An Inquiry how Iron and its Preparations act on our Fluids, 1713.

No part of Natural Philosophy is so capable of satisfying the curiosity of an inquisitive inquirer as Chemistry; every process agreeably

greeably surprizes him by its novelty, and when this ultimately tends to the improvement of medicinal knowledge, there is scarce a process, from which some thing relative to the theory and practice of medicine might not be learned. M. *Lemery* the son, had this in view in all his former experiments with iron, and from them endeavors to account, 1st, how the preparations of iron act upon our fluids: 2dly, to discover the best method of employing it as a medicine: 3dly, which are the best preparations of iron, and occasionally, to shew the folly of those who torture it by all manner of ways, under the specious pretence of preparing it, whereas all such preparations do rather injure than improve its medicinal virtues.

It has been before observed *, that iron is composed of a sulphurous, easily inflammable matter, and a metallic earth, both which are so loosely united, that any liquid in Nature is able to disunite them, *i. e.* dissolve iron. This observation alone was sufficient to inform us, that iron wanted no preparation, the gastric juices alone are able to extract its medicinal virtues, this daily experience evinces in the cure of the *chlorosis*, and other obstructions of the bowels, where it acts as an absorbent to obtund and correct those acid juices often lodged there; and as iron, by the gentlest heat is known to part with

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* See before p. 119.

its active, sulphurous parts, so the Natural heat of the body will be sufficient to extract those active sulphurous parts, to set them at liberty to act upon our fluids, to attenuate the sily lymph, and separate the same, and by accelerating the circulation of the blood, as it is always observed to do, to eliminate and discharge the same, by the proper outlets; that this or some such thing happens, upon taking the filings of steel, is evinced from the following observations.

The pulse is perceivably raised, becomes fuller, the heat is sensibly increased, and diffused thro' the whole body, the face, from a dead pale, soon acquires its natural florid color, hemorrhages often attend the use of those filings of steel; this observation alone sufficiently shews, that some new, active agent is now mixed with the blood, which has wrought those changes in it, and which can be no other than those filings of iron; its metallic parts by their specific gravity, help forward the depuration of the blood, just as *isinglass* is known to promote the depuration of wine, when overloaded with tartarous and earthy parts; as therefore the chief medicinal virtue of iron seems to consist in its active sulphurous parts, and that the metallic parts, deprived of these sulphurous parts, become indissoluble by our juices, so it is evident to a demonstration, that

that all *crocus's*, how much, and how long soever cried up by some Physicians, are destitute of the medicinal virtues of iron, and in that case, they rather oppress by their weight, the stomach than contribute to its relief, to remove any of its complaints, much less to remove those more remote disorders they were intended for.

All *crocus's*, even what is prepared without the assistance of fire, are more or less a calcination of iron, which deprives it of a good deal of its native sulphur, consequently of its principal medicinal virtue; the fond ill grounded notion, that such preparations are necessary to open this metal, to render it capable of being dissolved by our juices, is false in fact; for iron is soluble in any liquid, but after it is reduced to a *crocus*, it becomes almost indissoluble in the strongest mineral acids; how then cou'd we expect it shou'd be dissolved by the juices of our stomach, much less be carried further into the blood, there to act upon it? these *crocus's* must therefore rather oppress the stomach by their weight, as was before taken notice of; reiterated experience has confirmed this truth, notwithstanding, so strong are the prejudices of some in favor of such preparations, that iron without been prepared wou'd, they fancy, be attended with more inconveniencies; and here it were to be wished, that iron was the only
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medicine that suffered by being tortured by chemical processes; we have many that come ready prepared from the hand of *Nature*; a judicious application is all they want.

M. *Lemery* affirms that the filings of iron operate much sooner, and with less inconvenience, and sit lighter on the stomach than any *crocus* whatsoever; for they are by far more soluble than it or any other preparation whatever, they consequently will remain a shorter time in the stomach, the blood and humors will therefore sooner receive their salutary influence, raise the languid pulse, accelerate the circulation and depurate the blood.

In confirmation of this he observed, that in *Languedoc*, where the *chlorosis* is endemial, they employ the filings of iron preferably to all other its preparations, which are found to remove all those disorders in a short time, *Sydenham* that sage practitioner, always gave the preference to those filings, and from a long experience of their virtues assures us, they act both more speedily and effectually than any other preparation of iron, even the *crocus* prepared by the *May* dew, which some highly esteem, or that prepared by rain water, is by far less soluble than the filings of iron; for such liquors as very readily dissolve iron, wou'd make no impression on this *crocus*, and such as do act upon it, are observed to act very

ry readily on the filings; this alone shou'd convince us, that those filings are fitter for medicinal uses than even this *crocus*, so much cried up for its medicinal virtues.

M. *Lemery* thinks that the best preparation if any, wou'd be a tincture, made in an infusion of some known medicinal plant, which wou'd keep its metallic parts suspended, and in their liquid form, wou'd sooner get into the blood, without much fatigue to the stomach. This wou'd be a desirable circumstance, especially where the fibres of the stomach are very delicate, and easily irritable.

This tincture shou'd not be made, as is the custom, by boiling crude tartar with those filings for 12 or 15 hours, in order as is alledged, to open those filings; such a preparation deprives them of their finer, sulphurous parts, in which consist their chief medicinal virtues; but it shou'd be made without the help of fire, by infusing those filings in the juices or decoction of some medicinal plant, which might rather forward their virtue; thus the filings of iron, infused in a decoction of the *cortex*, for instance, has been observed to increase the medicinal virtues of that noble *exotic* in such agues as are complicated with obstructions of some standing; those same filings may be very advantageously mixed with the decoctions of many others, as the several indications may seem to require; *verjuice*, the juices of *citrons*,
China

China or *Seville oranges*, *pomgranates*, the decoction of *balaufts*, *sumach*, *galls*, *rhubarb*, *myrobolans*, and many others will extract readily a tincture from thole filings ; even a solution of *tartar solubilis* in water, will extract as strong, and as good a tincture from the same filings as any decoction whatsoever ; and as to the salt of steel, cou'd it be deprived of its caustic, irritating quality, by which it is known to ruffle the fibres of the stomach more or less, it wou'd deservedly carry the preference from all its other preparations, as it contains in so small a mass, all the known virtues of iron ; besides, as it is so easily soluble in the stomach, its so much the sooner passes into the blood, there to display its virtues, to attenuate the fizy lymph ; to prevent the salt of steel's irritating the fibres of the stomach, it shou'd be well diluted in some proper decoction, or other appropriated liquor, or made up into pills with some mucilage, as that of gum-tragacanth, and given in the dose of 4 grains, thereabouts ; these 4 grains scarce contain one grain of iron, the other 3 grains are made up of the vitriolic acid, that dissolved the iron, and of the water this salt took in its crystallization ; it were therefore greatly to be wished, that this salt cou'd be deprived of its irritating quality, it might be given in a greater dose, its good effects on the blood wou'd be sooner perceived.

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M. *Lemery* thinks he has accidentally hit upon such a preparation in his vegetation of iron ; by pouring *lixivium tartari* on a solution of the filings of iron in the nitrous acid, a new concrete salt, a martial salt-petre is produced.

This salt differs from our common salt-petre, by still retaining some particles of the filings along with it ; as therefore common salt-petre is in its own nature, a mild and gentle aperitive, the particles of iron, now joined with it, being highly attenuated, must necessarily increase the salutary effects of this salt on our blood and humors ; but as this martial salt-petre renders whatever liquor it is dissolved in muddy, saponaceous, and somewhat disagreeable to take, M. *Lemery* was obliged to give it in pills, made up with a mucilage of gum-tragacanth ; he has given it in this manner, from a scruple to a dram in several obstructions of the bowels, in scirrhus and œdematous swellings, where there was very little secretion by urine ; he likewise gave it as an astringent and detergent medicine in the most inveterate gonorrhœa, and *fluor albus*, and affirms he never was disappointed in either of those cases, and he makes no doubt, but upon a fair tryal, it will be found a very efficacious medicine in many other cases.

Observations on Vitriol and Iron, 1713.

Vitriol has always afforded the Chemist abundant matter to exercise his talents, whether as a naturalist, he considers its composition, or as a Philosopher, he looks upon it as the *basis* or first principle of all metallic substances, which he hopes one day or other to be able to purify, so as to be convertible into perfect metals; or as a Physician, he considers it as the principal source of Chemical Pharmacy, from which he expects to extract many useful medicines, for the removal of a great many disorders. Several Chemists have made many experiments with vitriol in each of the above different views; M. *Geoffroy* the elder considers here the medicinal virtues only of vitriol.

He tells us there are three sorts of vitriol kept in the shops, the green, the blue and the white, all 3 contain the same *acid*, and differ only in their *basis*; in the green, the vitriolic acid is join'd to some particles of iron; in the blue to some particles of copper, and in the white to the *lapis calaminaris*, or to some particles of iron, join'd to others, either of lead or pewter.

The green comes either from *Leige* or from *England*; the manufacturers expose the *marcasites* or vitriolic ore to the air for some time, till it has fermented, and is covered with a saline

line *farina* ; the subsequent rains dissolve, and wash these saline efflorescences into cisterns, placed for that purpose, they put as much old iron into this solution of the vitriolic ore as it can dissolve ; they boil it down after to a certain point ; and set it after to shoot into crystals ; there remains after a reddish, thick and unctuous liquor, known by the name of the *mother-ley* of vitriol ; this liquor cou'd never be brought to crystalize, nor exposed to the severest frost wou'd it congeal, but exposed to the action of fire, it wou'd become a thick, dry, yellowish substance, unctuous to the touch, and extremely stiptic on the tongue ; yet free from all signs of acidity or corrosion, especially when the operator took care to separate all the vitriolic crystals from it ; exposed to the air, it readily deliquiates, runs into the same unctuous liquor it was before.

All fossil salts leave, after their crystallization, the same kind of *lixivium* ; and what is more remarkable, alum, salt-petre, sea salt, and vitriol, tho' ever so well depurated before, leave this same unctuous water in all their subsequent, and ever so often reiterated, solutions and crystallizations, and at each time deposit a subtile fine earth.

This unctuous water has a great affinity with all *lixivium*'s, or solutions of alkaline salts in water, such as *lixivium tartari* ; The Chemists looked upon this unctuous water to proceed

from the superfluous, abounding alkaline salt, which the acid cou'd not absorb or take up, and so it remained in the water, in this lixivial form ; but was this the case, when those salts were once well depurated and crystalized after, they never after shou'd leave this lixivial, unctuous water ; whereas the contrary is true in fact, *viz.* all fossil salts may, by reiterated solutions and crystallizations, be intirely converted into this lixivial, unctuous water ; M. *Geoffroy* treated vitriol in this manner, that is, he converted it into this lixivial, unctuous water, and had at each crystallization left on the filter a fine, subtile earth, which he looks upon to be the *basis* of iron.

M. *Geoffroy* gives us three different processes to obtain this *lixivium*, 1st, he dissolves, filters, and crystallizes his vitriol, as in the usual manner ; he laid by some of this solution, intending it for some other experiment ; in some months after, he observed it had changed color, and become of a deep red, and more stiptic on the tongue, and yet less acid than when first laid by, and had deposited a good deal of earth ; and at the end of two years, he found at the bottom of the vessel, a fine cake of green crystals, lying on a smooth mud, which rubb'd between the fingers, felt unctuous, and exposed to the air for a few days, became a dark, red, unctuous liquor,
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extraordinarily stiptic on the tongue, tho' no way acid.

In the 2d process, after he had dissolved, filtrated and crystallized his vitriol, as in the first, he exposed those crystals to the sun, till they were calcined, or reduced into a white *farina*; he after dissolved this calcin'd vitriol in filtrated rain water, and left it in digestion for some days, and then filtered it; he here found on his filter, an *ochery* kind of earth; he set this solution after to evaporate in the sun, and separated from this unctuous liquor what crystals were formed; and carefully laying by this lixivial water, he exposes his crystals to be calcined in the sun, dissolves them after, as in the former process, reiterating this *manoeuvre*, till all the vitriol he first employed was converted into this lixivial water.

In the 3d process he obtained at once more of this lixivial, stiptic water than in either of the former; he first distills his vitriol, to deprive it of as much of its acid as he can; the *colcothar* he thereby obtains is far more rarefied than what is made after the usual way, and of a brighter color; when this *colcothar* had been exposed some time to the air, it becomes a kind of paste; he dissolves this paste, filtrates and evaporates it to a pellicle, and sets it after to crystallize; he here has left a good deal of this lixivial, stiptic water, of a dark, red color, heavy and unctuous to the touch, extremely
stiptic

stiptic on the tongue, yet neither acid nor acrimonious, especially if the operator took care to separate the vitriolic crystals from it.

This lixivial liquor, by the heat either of the sun or fire, becomes a yellowish, saline mass, and exposed to the humidity of the air, it first becomes a kind of oil, and after a reddish liquor, which ferments violently with the nitrous acid, and grows warm only with the oil of vitriol; when it is mixed with *lixivium tartari*, it becomes, first a *coagulum*, and when dissolved after, it ferments violently; after the fermentation is over, a light mucilaginous *coagulum*, remains. This same lixivial liquor, reduced by the heat of the sun, or fire into the above saline mass, if calcined after, becomes a most beautiful *colcothar*, and exposed to the air, deliquesces readily into the same stiptic liquor it was before.

M. Geoffroy tells us, he gave this lixivial, stiptic liquor, with good success in hemorrhages, both internal and external; it is more stiptic than *aqua Rabeli*; yet it never excites either a *nausea*, or sickness of the stomach; it stops all spittings of blood, uterine *hemorrhages*, *fluor albus*. M. Geoffroy thinks it wou'd answer better in spittings of blood, ulcers of either the lungs, kidneys or bladder than the *tinctura anti-phthifica Pharm. Lond.* this lixivial, stiptic liquor has this in common with most of the

the preparations of iron, to be an excellent *emmenagogue*.

This and all other preparations of vitriol owe all their virtues to the particles of iron, contained in the vitriol ; these particles of iron, are both aperitive and astringent ; these seeming opposite virtues, one time to check the immoderate flow of the *menfes*, at another time to restore them when suppressed, to stop fluxes of the belly, at other times to open the bowels, to remove obstructions from a fizy lymph, by attenuating it, brace and wind up relaxed fibres, and at another time to thicken this same blood, so as to recover its due *crasis* whenever it has lost it ; these and many more seemingly opposite effects wou'd be justly looked upon as a *paradox*, had not daily experience evinced the truth of them, and proved that the preparations of iron act in this twofold manner, as an astringent and as an aperitive ; it was this that induced Chemists to distinguish those preparations of iron into a *crocus martis astringens* and *aperiens*, *aperitive salts*, *tinctures*, *magisteries*, &c.

When we come to inquire how those preparations of iron come to act in this twofold manner, we can attribute these seemingly opposite effects to nothing else but to their stipticity ; for when we consider that most of the disorders, those preparations of iron are found serviceable in, proceed from one and the same cause

cause, the *atonia* of the vessels, thro' which all the humors of an animal body constantly circulate, as also of the secretory and excretory ducts of the several strainers or glands of the body, which may here be considered as a continuation of the same blood vessels; when therefore the fibres of the several orders of those vessels are relaxed, or have lost their springiness, the fluids each vessel carries about, when left to themselves, soon become fizy, obstructions will necessarily be formed, the fluids thus obstructed in their progressive motion, must naturally distend their respective vessels, the consequence must be, that these fluids must, either ooze thro' the relaxed coats of the vessels, or lacerate and tear the same; probably it is after this manner that hemorrhages are produced, as also dropsies, as this or the other order of vessels happens first to give way, or is ruptured; how the preparations of iron, by their stipticity, set all things to rights, remove all those opposite ailments, is by bracing and strengthening the texture of the several orders of vessels; the natural springiness of the vessels once restored, their own action on the contained fluids will soon comminute the fizy blood and lymph, restore them to their former fluidity; the circulation thus gradually restored to its natural state, the several secretions from the blood will be regularly made; thus the *catamenia* which thro' the relaxation of
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of the vessels were suppressed, by bracing up those vessels, will be restored ; the immoderate flowings of the same, owing to a relaxation of the uterine vessels, will by being braced up, be checked, as well as all other hemorrhages, dropfies, &c. proceeding from the same relaxation, provided those disorders are not permitted to remain too long, so as to be rivited into the habit ; in such a case, it may be reasonably apprehended, that these same preparations of iron might be attended with very fatal consequences ; for by increasing the springiness of the vessels, and thereby accelerating the circulation of the blood, the blood is then impelled with so much new acquired force against those insurmountable obstructions, as we too often find is the case, when imprudently given in confirmed dropfies, scirrhus and scorbutic affections, hectic fevers, inveterate, hypochondriac cases, where they generally bring on either hemorrhages, colliquative sweats, or incurable fluxes, which soon close the scene, by putting an end to the poor, unhappy patients life.

M. Geoffroy tells us, Physicians are greatly divided about the choice of those preparations ; some prefer steel to iron, others iron to steel, others again prefer the filings of iron to all its other preparations, some prefer the *crocus* prepared by the *May* dew, others that prepared with sulphur, and others that prepared with

salt of tartar ; M. *Geoffroy* thinks that prepared by the *May* dew has justly the preference of all other its preparations, as being more attenuated and less altered, the *saliva* and gastric juices, being a *salino-sulphuribus menstruum*, will therefore more easily extract a tincture from this *crocus* than from the filings of iron ; iron for the same reason is preferable to steel, as being more open, and as to all the other *crocus*'s, they are either loaded with acids ; or if the fire in their calcination has expelled those acids, it has likewise deprived them of their fine sulphur, which is not the least useful part of them, by which means they become indissoluble in the juices of the stomach ; whereas the *crocus* prepared by the *May* dew, is open and easily soluble in any liquor, sits light on the stomach, and therefore passes sooner into the blood.

But of all the preparations of iron M. *Geoffroy* prefers a liquid one, a tincture ; the particles of iron will, in such a form, more readily mix with our juices, and therefore be sooner carried into the blood, there to display their medicinal virtues, and that without fatiguing the stomach ; what M. *Geoffroy* generally gives, is a *vinum chalybeatum*. Wine being a proper *menstruum* to dissolve iron ; the sulphurous part of the wine takes up the fine sulphur only, while the acid in the wine dissolves the ferruginous parts, both which are

are as highly attenuated as they possibly can be, and kept suspended in the wine, which by that means becomes an excellent medicine, capable of penetrating the most remote vessels of the body, and of course to incide and remove any impacted matter, that may obstruct, or adhere to the sides of those vessels; 4 ounces of this wine given in the morning fasting in some appropriated decoction, and as much in the afternoon, have been attended with good success in a suppression of the *menfes*, and other the like cases; or the same quantity of this chalybeate wine might be extended in a quart of water, and drank to as good effect as an artificial chalybeate-water. In great weakness of the stomach and in *dibarrhæas*, a table spoonful of this wine, added to every glass of liquor the patient takes, has been attended with very good effect; but in spittings of blood, in ulcers both of the lungs, kidneys and bladder, M Geoffroy wou'd prefer the *tinctura anti-phthistica* P. Lond. or rather the following from Zwelfer. R. *terræ foliatæ tartari et vitrioli martis ana q. v.* grind them together, infuse them after in spirits of wine; this tincture acquires a beautiful, red color, the *terra foliata*, as a *salino-sulphurious-menstruum*, dissolves the sulphurous parts only of the iron, which it very readily parts with after to the spirits of wine; and even of this sulphur, the spirit

takes up the highly attenuated sulphurous parts only, and such particles of the iron as are inseparable from them. This tincture is not only efficacious in correcting the acrimony of the blood and lymph, which always retards the cure of all such inward ulcers, but being both balsamic and vulnerary, it deterges, and at the same time consolidates the same; whence it justly acquired this *epithet*, *Pungit et unit, sauciat et sanat.*

The French Surgeons employed to good purpose in the last war, a composition made of the filings of iron, and crude white tartar, equal parts, which they made into a paste with white wine, exposing it to the sun, during the summer season; and stirring it often, till it became a dry powder; they powdered it anew and with wine made it again into a paste, repeating this same process, till the whole was reduced into an impalpable powder, which they made up into balls with brandy; these balls were afterwards dried in the sun; whenever they employed them, they infused them, either in wine, brandy, or when they cou'd get neither, in fresh urine; if the wound was simple only, they did but wash it with this tincture; but if it penetrated, or was otherwise complicated, they injected this tincture, and if there was an artery open, they scraped some of those balls on the cut artery, laying over the whole compresses

presses dipped in the same tincture ; they also employed the same tincture to good purpose to dry up old ulcers.

It was with balls of this kind that *Willis* made his artificial mineral waters, which he gave to his patient with so good success. *Maet's mars potabilis* is no more than a tincture from balls of this kind ; there are many other kinds of balls, as the *lapis medicamentosus*, *lapis mirabilis*, *lapis salutis*, &c. *M. Geoffroy* saw very good effects of this *.

To volatilize the fixed Salts of Plants, 1714.

The fixed salt of plants is no other than their natural salt, deprived for the most part of its volatile parts, by the great action of the fire, viz. of its *flegm*, acid and urinous salt and oil ; now, to volatilize this salt, all that
is

* Take the filings of iron and *lapis hæmatitis* of each 3oz. creme of tartar, 6 oz. make into a paste with white wine, digest as in the preceding process, repeating it till all the filings are reduced into an impalpable powder, then add mastic and saffran in powder, of each half an ounce, dissolve in the wine myrrh and aloes, of each an ounce, moisten the powders with this wine, and add it to the height of 4 fingers, leave the whole in digestion, stirring it now and again, evaporate what remains to ficcidity, powder it anew, and make into balls with brandy, which dry in the sun. and keep in bottles for use.

The tartar here opens the particles of iron in both the filings and *lapis hæmatitis*, the sulphurous part of the wine opens their sulphur, by which means it becomes, both balsamic and vulnerary, capable of deterging and consolidating all wounds and ulcers. The gum and resins here added must conspire to render these effects more salutary.

is necessary is to restore to it those volatile parts the fire deprived it of.

Chance furnished M. *Homberg* with the means to volatilize this salt ; not pleased with the common wash-balls, he made some himself with *Genoa* soap, scenting them with oil of lavender and a few drops of the essence of amber ; after these balls lay exposed to the sun to dry, he was greatly surprized to find them covered with an efflorescence, like the *nitrum muriale*, but that it wou'd not fuse like it, tho' it cast a good deal of vapors, which, tho' they were neither acid nor urinous, M. *Homberg* conjectured they might contain a volatile salt, which in proper vessels might be retained ; his curiosity thus raised, in order to make the experiment, he carefully collected all the saline efflorescences of his wash-balls, and when they grew hard and dry, so as to afford no more, he had them laid in the vault, where they soon began to vegetate, and be covered with the same saline *farina*, and when they wou'd give no more, he washed off their hard, saline crust, and dissolved in the same water all the salts he obtained, which he distilled after in a glass alembic, with its head and receiver by a slow fire, observing here the same process as in making his *sal-sedativum*, i. e. returning back on the matter in the cucurbit the distilled water, as long as any salt wou'd rise ; at the end of the operation
he

he found, adhering to the sides of the cucurbit, and in its head a concrete salt, in white fleaks like snow, and not unlike his *sai-sedativum*, which weighed 3 *drs.* on the palate it came nearest to salt-petre, it fermented lightly with the marine acid, and gave a feeble red color to the tincture of *Tournsol*, laid on an ignited iron, it soon melted, and exhaled after in vapors, but wou'd not fuse as salt-petre does.

This process informs us that a part of the fix'd salt of kelp, must be here volatilized, to produce this concrete salt, and as *Paracelsus* and *Van-Helmont* boasted so much of their volatilizing the salt of tartar, M. *Homberg* made a soap with it also, and treated the saline efflorescences, the balls he made with it afforded, exactly as in the former process, and obtained the like volatile concrete salt from them.

M. *Homberg* conjectured he might still abridge the process, had he made his soap with a volatile, instead of common oil, accordingly he took the volatile, fetid oil of tartar and the salt of tartar well purified, and made this soap into balls, when these wou'd afford no more saline efflorescences, he pounded them in a mortar, adding more of the same oil, this paste he put into a cucurbit with its head and receiver on, adding a little spirits of wine to it, he distilled it after with a slow fire, observing to return back the spirit

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rit drawn off each time, after rectifying it. This process he repeated 12 times, by which means near one half of the salt of tartar employed is volatilized.

There is a considerable difference between the quantity of salt obtained by this and the former processes; besides, 12 sublimations were here sufficient, whereas above 50 were necessary in the former, to raise and bring over all the salt that wou'd sublime. This is partly owing to the nature of the oil made use of, the oil in the last process being volatile, more readily obeyed the action of the fire, the vehicle here also being volatile, the volatile salt rises more readily with it than with the water, employed in both the preceding processes.

M. *Homborg* attributes this volatilization of fix'd alkaline salts to the decomposition of the soap; this every one knows is composed of either oil or animal fat, and an alkaline fixed salt, which had been deprived, by torture of fire, of its acid, it will therefore greedily catch at its acid, wherever it finds it; all oils and animal fat are known to contain an acid; we shou'd not therefore be surprized to find, this fix'd alkaline salt had seized this acid, and by the assistance of the fire, had sublimated after in the form of a concrete, volatile salt.

A Chemical PARADOX, acids will ferment with Acids, and Alkalies with Alkalies,
1714.

The general doctrine of acids and alkalies is, that they will always ferment with each other, they being constant antagonists; but that an acid shou'd ferment with an acid, or an alkali with an alkali, seems to overturn this whole system.

M. *Poli* has discovered that the marine will ferment with the nitrous acid, and what is more, that the volatile spirits of sal ammoniac, urine, and harts-horn, will ferment with salt of tartar.

M. *Poli*, obtained a concentrated spirit of sulphur, which wou'd ferment with water alone, which is neither acid nor alkali; this water becomes not only hot, but boils; he obtained this concentrated spirit by distilling the common spirit of sulphur *par campanam*, and by gradually increasing the fire, the *flegm* comes over first, a most powerfully acid spirit comes after; every drop as it fell into the *flegm*, made the same hissing noise that a red hot iron put into cold water wou'd; when his vessels are cold, he finds in his retort this concentrated acid, as clear and as transparent as crystal, and nearly as heavy as quicksilver.

Of Petroleum, 1715.

This is a liquid balsam, so called from its trickling thro' the clefts of some rocks. The eastern countries have been long known to produce this kind of liquid bitumen, before there was any of it discovered in our european countries; *Olearius* tells us he had seen 30 sources of it near *Scamacchia* in *Perha*; what we now have, comes from a barren valley in the bailiwick of *Montfestin*, 12 miles from *Modena*; one *Fr. Ariosta*, a Physician at *Ferrara*, was the first that discovered this mineral liquid balsam in 1640, the proprietors have been at great expence to make proper *reservoirs* to retain it in.

There are 3 sorts of *petroleum*, the first and best sort is as white, clear and liquid as water, of a most penetrating, tho' not a disagreeable smell, the 2d is of a bright yellow, less liquid than the white, and of a more disagreeable smell, the 3d sort is of a dark red, thicker than either, and of a disagreeable, bituminous smell. The *Italians* seldom let us have any of the first sort; it were well they wou'd let us have the 2d sort unadulterated, the first is of so penetrating a smell, that we are told, it is sensibly perceived, before one comes within half a league of the source.

M. Boul-

M. *Boulduc* by some good fortune got some of the first sort; it presently catches fire, and by only warming it over the fire, the subtile vapor it even then exhales, attracted the flame of a small wax light, which was held some feet above it, and when once a fire, it intirely consumed itself. It will likewise intirely consume over water, and float on all kinds of liquors, and even on spirit of wine, which is $\frac{1}{2}$ heavier than it; *petroleum* will mix with all the vegetable oils, *viz.* of thyme, lavender, turpentine; this, as well as the vegetable oils, comes from the same source, the *bitumen* of the earth; when it is violently agitated, it forms a great many bubbles, like all other liquors, but they disappear sooner in it than in any other. It never congeals in the most intense frost.

It is incredible how it extends on water; one drop wou'd cover 6 feet square, forming several *prisms*, capable of refracting the rays of light. Ever so long kept in digestion with spirits of wine, it yields no tincture to it; and if set to distill in either MB. or BA. neither spirit nor *flegm* wou'd come over, but an oil only, and what remained in the retort was a thick, brownish substance.

Of the origin of Sal Ammoniac, 1716.

There is scarce a drug more in common use than sal ammoniac, and yet what is very

extraordinary, we have been hitherto ignorant, not only how it is made, but even from whence we have it; as it came formerly by the way of *Venice*, some imagined it was made there; but we now know it comes from *Egypt*, but from what part of *Egypt* is still unknown.

Chemists have long since discovered, that it contain'd an acid joined to a volatile alkali; they have even been able to imitate it, by distilling common salt and urine.

M. *Geoffroy* the younger, making some experiments with human urine, happened to compose a sal ammoniac, in every thing like what is imported; when he read his Memoir this year before the Academy, M. *Lemery* objected that the sal ammoniac of the shops cou'd never be made by sublimation, the very figure it is brought to us in (in flat cakes), necessarily excludes sublimation, no salt sublimated in our furnaces was ever known to assume the shape of the subliming vessel, but are in a kind of *farina*, which Chemists have called flowers; besides, the low price it comes to market at, M. *Lemery* thinks another strong reason, why it cannot be made by sublimation; for how great must be the expence in materials, subliming vessels, labor and freight? for these reasons he conjectures that sal ammoniac is made in much the same manner of our common salt, by evaporation, preceded
by

by the necessary lotions, to purify the matter; nor is it impossible but there may be a fossil sal ammoniac, as there is a fossil sal-gem; we have before seen the account of a sal ammoniac gathered at the foot of *Mount-Vesuvius* *. We know that some earths are naturally saturated with one kind of salt, and some with another; this earth might be supposed to be impregnated by the urine of several animals; it is not therefore very difficult to conceive, how the ardent heat of the sun, in those eastern countries may unite this fossil acid with the volatile salt in the urine of those animals, so as to produce a sal ammoniac; what helps to strengthen this conjecture is, that several plants are known to contain a sal ammoniac, others a vitriol, others a salt-petre.

These reasons had then their weight with the Academy, who is always cautious to give a sanction to any facts, before it receives the most unquestionable vouchers, accordingly, M. *Geoffroy's* Memoir was suppressed for the time, so the matter lay over to the year 1719, when M. *Lemere*, Consul at *Grand Cairo*, sent the Academy the following account of the manufacture of sal ammoniac in *Egypt*.

As

* See before p. 146.

As there is very little wood in *Egypt*, most of their fuel is a composition of the dung of their domestic animals and chopped straw, made up into cakes, which they set to dry in the sun. The soot arising from this fuel is carefully gathered, and put after into great, round glass bottles, exactly of the figure of our bombs, a foot and a half in diameter, with a neck 2 fingers in height; they coat these bottles with a fat earth, and fill them with soot, to 4 fingers short of the neck, and place them afterwards in furnaces, fitted for that purpose, wherein a fire of the same fuel is kept up for three days and three nights, during this time, all the *flegm* in the soot is exhaled, the salt sublimates at the neck of the bottle, in the form of a flattish cake, in which they are exported; each bottle contains 40 pounds weight of this soot, which at the end of the operation yields 6 pounds of sal ammoniac.

Each furnace contains 16 bottles, and in every laboratory there are 8 furnaces, so there are 128 bottles in every laboratory set to sublime this salt; in 2 villages near *Delta*, there are 25 of these grand laboratories, besides some smaller ones; upon an average, they make yearly from 1500 to 2000 quintals (hundreds wt.) of this salt; in all *Egypt* besides there are but three laboratories, 2 in *Delta*, and one at *Grand Cairo*, which make from 20
to

to 30 quintals of this salt; it is to be observed, no other but the above kind of soot will yield sal ammoniac.

However mortifying it was to M. *Geoffroy* at the time (1716) to have his Memoir suppressed, he had ample satisfaction after, to find by the accounts the Academy received from the above consul, that what he had advanced, relative to the composition and manufacture of sal ammoniac was true in fact.

M. *Geoffroy* pursuing his inquiries in another Memoir 1720, made sal ammoniac with all kinds of animal substances, such as blood, urine, horns, leather, hair, old woollen rags, &c. all that is necessary is to unite a volatile alkali with a volatile acid; and as we know that the marine acid is by far the most volatile in nature (it will volatilize metals and *mercury*), so it is the fittest acid to be employed in the manufacture of sal ammoniac.

To make an extemporaneous SAL AMMONIAC.

Take sea salt and any animal substance you please, of each q. v. harts horn, for example, and the weight of the whole of pipe clay, put this mixture into a retort, placed in a reverberatory furnace, by managing the fire as usual, the *flegm* comes over first, the volatile spirit mixed with a little oil comes over after, and upon raising the fire, the salt will
be

be found, caked about the neck of the retort. Take out this salt, and mix it with about half its weight of pipe-clay, set it to sublime as before; you will have a fine, white sal ammoniac, which will want no further preparation, tho' it may be rendered still purer by dissolving it in water, filtering, evaporating and crystallizing it, after it becomes a light, white salt.

There is still a more expeditious way of making a sal ammoniac; pour the marine acid on any volatile alkaline salt or spirit to *full-saturation*, evaporate the superfluous *flegm* in a sand heat; you will have a *sa'salum*, to all effects as good as the common sal ammoniac of the shops.

By these experiments, we now know that sal ammoniac might be made with human urine alone, this urine contains a good deal of sea salt; but when the urine of other animals is employed, sea salt must then be added; their urine is known to contain very little common salt.

Lastly, these same experiments inform us, that in case we shou'd get no more of this salt from *Egypt*, we might very easily manufacture it at home; for we now know that all animal substances, old rags of wool, silk, pieces of skins, hair, &c. and sea salt, will always yield this kind of salt; for this purpose, it is only erecting a laboratory, where
labor

labor and fuel are cheap, and sea salt in plenty. It cannot be well objected to this, that this salt wou'd come much dearer to market than what it now sells for, by reason very great quantities of the necessary materials wou'd yield but a very small quantity of this salt; for let it be here considered how much time and expence is expended in making of sugar, how little juice each sugar-cane produces, and yet after all this vast expence of time and labor, sugar is sold for less than one half of the price of our sal-ammoniac of the shops.

M. *Geoffroy* still pursuing his inquiries while the plague raged at *Marseilles* in 1720, thereby interrupting all commerce with the *Levant*, obliged him to send to *Holland* for this salt, which was of another form, like a sugar-loaf, with the top cut off, and imported from the *East-Indies*; the figure of this salt gave him great pleasure, as it still confirmed what he had advanced in 1716, concerning the manufacture of sal-ammoniac by sublimation; what he now wanted, was to discover the proportion between the acid and alkali; M. *Tournefort* in 1700, cou'd obtain but $\frac{2}{3}$ of a volatile dry salt, which however, is more than any Chemist before him cou'd; for from 15 ounces of sal-ammoniac, he had 10 ounces of a volatile dry salt, and $3\frac{1}{2}$ ounces of a volatile spirit, which may be supposed to con-

tain 6 drams of the same salt, making in the whole 10 oz. 6 drs. M. *Geoffroy* obtained above $\frac{3}{4}$ of the same volatile dry salt; the difference in the produce by both processes he conjectures was owing to M. *Tournefort*'s not employing a sufficient quantity of an *intermedium*; besides, he took no account of what was lost in the operation.

M. *Geoffroy*'s method is this, he dries both his salts perfectly well, and while they are yet warm, he puts them into his retort, taking care to cork it close, he lets them remain so for 24 hours, and then adds $2\frac{1}{2}$ ounces of the spirit of wine to each pound of sal ammoniac he employs; here again he leaves the matter in digestion for 12 hours, to give the spirit time to diffuse itself, and penetrate the salt, and even excite a gentle fermentation, which helps to detach the acid from the alkali, which by that means abridges the operation (the volatile salt comes over the sooner); he then adapts 2 receivers to his retort, the first having an apperture at each end, in order to preserve a communication between the retort and the 2d. receiver, and after he has luted the junctures, he raises the fire by degrees, in order to raise a very gentle sublimation by the heat of the reverberatory; the spirit comes over first, a part condenses on the sides of the first receiver, the remainder passes on to the second, while all the volatile salt comes over, and

and firmly adheres to the side of the first receiver; when the vessels are cold, and unluted, a separation is made; what liquor is found in both receivers is near equal to the spirit of wine employed, and found to contain a volatile salt; for after some days it deposites a salt in the form of needles, and when emptied into another bottle, it will again deposite more salt.

M. *Geoffroy* employed in the above process, 1 pound of sal ammoniac, 3 of salt of tartar and $2\frac{1}{2}$ ounces of the spirit of wine, the whole making 4 pounds, $2\frac{1}{2}$ ounces; the produce was as follows, 13 ounces, 3 drams of a volatile salt, 1 ounce, $5\frac{1}{2}$ drams of a spirit, besides 1 ounce $\frac{1}{2}$ dram the papers round the junctures had imbibed; the whole making 16 ounces 1 dram of a volatile salt, from which we must deduct $2\frac{1}{2}$ ounces for the spirit of wine employed, and there will remain 13 ounces 5 drams of a volatile salt, which a pound of sal ammoniac yielded by this method.

The *caput mortuum* in the retort weighed 3 pounds 1 ounce, which ounce of overplus must be the weight of pure acid, contained in a pound of sal-ammoniac; but as the above 16 ounces 1 dram of a volatile substance, found in both receivers, with the 3 pounds 1 ounce, found in the retort, make but 4 pounds, 1 ounce, 1 dram, there is a loss of 1 ounce,

C c 2

3 drams;

3 drams; this must be the volatile salt, which during the operation, exhaled thro' the junctures and lutes, and which no care can prevent; so adding this loss of 1 ounce 3 drams to the above 13 ounces 5 drams of a volatile salt, it will be found, that a pound of sal-ammoniac contains 15 ounces of a volatile alkaline salt, and but 1 ounce of pure acid, which probably may appear a *paradox* in Chemistry.

Be that as it may, it cannot be alledged that a part of the alkaline salt, employed as an *intermedium*, was volatilized during the operation; for was that the case, the *residuum* in the retort must be by so much diminished in its weight; whereas it is rather increased by 1 ounce, which as was before said, is the proportion of the acid to the alkali, that is, half a dram of an acid to every ounce of a volatile alkali in sal-ammoniac *.

* Volatile salts are of great use in practice, and wou'd be much more so, cou'd they be deprived of their disagreeable smell and taste. Many attempts have been made to separate this fetid oil from them, but they sooner or later recover their former disagreeable smell. M. *Geoffroy* has, by the many experiments he made with sal-ammoniac, happily hit upon a process, which effectually answers the end, it is by converting them into a sal-ammoniac, and purifying it after by the necessary lotions, and to have the volatile salt separate, to decompose the sal-ammoniac by the assistance of the salt of tartar, as in the preceding process. The salt will sublime intirely free from its disagreeable smell, a thing long and ardently wished for.

Of

Of the Origin of Salt-petre, 1717.

The manufacture of salt-petre is well known, as it makes a principal ingredient in the composition of gun-powder; but where this salt is first prepared, or from what source it comes, is not so well known. Salt-petre by its *analysis* is known to contain an acid, united to a fixed alkali, which appears to be essentially different from what we call the mineral acids, the vitriolic and marine acid; for if any of those acids was pour'd on an alkaline salt, on salt of tartar for example, no salt-petre wou'd result from the mixture, but either a vitriolated tartar or what is called regenerated sea salt, as the one or the other acid had been employed; whereas, if the nitrous acid and salt of tartar had been employed, salt-petre, and no other wou'd be then produced, a salt essentially different from any of the former in all its sensible qualities, it becomes cool upon the tongue, it fuses when put on a live coal, it both excites and hastens the inflammability of all sulphurous substances, and whenever it is mixed with them, it suddenly produces a flame and a considerable detonation ensues, properties fossil salts are not found to be endued with; all which sufficiently evince, that the acid in salt-petre is essentially different from that *universal acid* found in, and extracted from all other, mineral or fossil concrete salts,
all

all these differing only in their *basis*; it is this *basis* that constitutes and characterises this or that salt.

It may be here be objected, that there is in all *Nature* but one *universal acid*, which is contained in the bowels of the earth, and passes from thence along with the sap into the roots of all trees, plants, which become after food for animals, who in their turn become food for other animals; so whether this acid is immediately extracted from the earth, or by a chemical process, had from vegetable or animal substances, it is still one and the same, the *universal acid* of all bodies, consequently the nitrous acid does not differ essentially from the other mineral acids.

Tho' it cannot be denied but that this *universal acid* passes into the plant, and from it into the animal that takes it for his food, yet it is sufficiently obvious this *universal acid* does not always preserve its own Nature, but visibly suffers some change from the plant that receives it; this is the case of the nitrous acid, which tho' it be confessed to come from the earth, and with propriety may be so far consider'd as a mineral, yet what constitutes it nitre, is the change it suffers by its division, and perhaps fermentation in the plant, whereby it differs from all the mineral acids we know.

The following experiment of M. *Lemery's* sufficiently evinces that the *universal acid* suffers

fers some change in its passage from the earth into the plant, which constitutes its nitre. He took some of the earth whereon several plants, known to contain nitre grew; such as borragé, purslain, and many others; this earth surely shou'd by its *analysis* yield nitre, did it originally contain any; yet by all the tryals he made, he never cou'd extract any nitre from it; what this earth constantly yielded was a vitriol, or a sulphur. From this experiment alone, it is sufficiently obvious that the above plants changed the *universal acid* into that of nitre; otherwise these plants by their *analysis*, shou'd yield a vitriol, or sulphur, and not a nitre, as the earth they grew on yielded a vitriol or sulphur, and no nitre. The consequence is self-evident, the plant wrought that change in the *universal acid*, which characterises it nitre or salt-petre; what was in the earth a vitriolic acid, becomes an acid of a different Nature in the plant, a nitre or salt-petre *.

Something *analogous* to this is observable in the *analysis* of plants and animals, what was a fix'd salt in the plant becomes a volatile salt in the animal, who took it in for his food and *vice versa*. How this change happens, M. *Lemery* conjectures is thus—all alkaline salts are concrete salts, half decomposed, that is, deprived of the greatest part
of

* See before p. 78.

of their acid, which is all the alteration they suffer'd; for by returning the acid, they were deprived of, they become the same concrete salts they were; now, when the nitrous acid for example, passes from the plant into the animal and *vice versa*, the only change it suffers, is to deposite some of its earthy parts in its passage from the plant to the animal, and in their place, it takes up some of the sulphurous parts of the animal, by which means it becomes volatile, *i. e.* obeys the least action of fire, and when this same nitrous acid returns to the plant, it as freely parts with those sulphurous parts to join its primitive earth again, and becomes fix'd, that is, resists the highest action of fire; wherefore, as no earth has hitherto been found to contain nitre or salt-petre, unless it was previously impregnated with either vegetable or animal salts, so it is indisputably a matter of fact, that all our nitre is either a vegetable or animal salt, and not a fossil salt.

This is still further demonstrable, by considering how nitre is now made in all parts of *Europe*. The manufacturers of salt-petre are known to choose the ruins of old buildings, the squalid earths of stables, pigeon-houses, bog-houses, church-yards, &c. all places well known to be highly impregnated with animal salts; and what is here chiefly worthy of observation is, that the under *strata*

ta of those same places are known to yield no nitre, which wou'd not be the case, was nitre a fossil salt; the upper *strata* therefore received their nitre from the vegetable or animal salts they were impregnated with, which not being able to penetrate further than a certain depth, the under *strata* for that reason never yield any nitre.

Further, if nitre was a fossil salt, like the other fossil salt, *viz.* sal-gem, vitriol, alum, it wou'd manifest itself in some of our mineral springs, as those fossils salts are known to do; and probably it was for this reason (no mineral waters or under *strata* of the earth been known to yield nitre), that some fancied the air was the *grand magazine* of this nitre, which it keeps in a fluid state, as sal-gem is kept in the ocean, ready to be deposited in all earths fit to receive it, from whence it is afterwards extracted. *Mayow* was a strenuous assertor of this *aerial nitre*, a fond opinion, believed even this day, tho' often combated, and intirely refuted by *Barchusen* and *Schelbamer*; but *M. Lemery*, by the following experiment, has for ever buried in oblivion this whimsical notion of aerial nitre; he exposed three different alkaline substances, *viz.* lime, salt of tartar, and washed earth on three earthen plates, placed on benches raised above the ground; these substances lay thus exposed to the open air, for upwards of 2 years, shelter'd from

the rays of the sun, as the patrons of this system recommend, when they direct to expose the earth to receive this pretended *aerial* nitre; when he made the usual elixations of these 3 substances to extract this nitre, they not only yielded no nitre, but did not even afford the least *vestige* of their containing any of it; but when these same substances were impregnated with animal salts, with urine for example, they soon after yielded nitre pretty plentifully.

This single experiment is sufficient to overthrow this fond opinion, of the air's being the inexhaustible source, which supplies all this terraqueous globe with nitre; for surely if the air contained this nitrous acid, how came it that not one *atom* of it came to lodge in the above alkaline substances, exposed for 2 years and upwards to its influence? It cannot with any color of argument be alledged that the above substances were not fit *matrices* to receive it, seeing these same substances, when they were impregnated with animal salts, yielded nitre in great plenty.

It must therefore henceforward remain an undeniable fact, that nitre is never to be found in the bowels of the earth, as all other fossil salts are; nor is it contained in the air, as many hitherto fondly believed; but is either a vegetable or animal salt, extracted from such earths, and from such only, as have been impregnated

pregnated with either vegetable or animal salts; for both vegetable and animal substances contain nitre already formed; the only difference between the vegetable and animal nitre is this, the nitrous acid in the plant is joined to a fixed alkali, which it exchanges for a volatile alkali in the animal, as was before explain'd.

As to the nitre imported from the *East-Indies*, this is entirely a vegetable nitre; those uncultivated grounds abound in such plants, as are known by their *analysis* to contain nitre; the heavy rains, that at certain seasons are known to fall in those countries, remain for a considerable time on the plains or flat grounds, where they macerate, and as it were rot the ligneous parts of those plants, and extract what nitre they contain, which they after wash into the lower grounds and ponds, from whence it is extracted in the same manner as with us, which lead several into an error, imagining that it was a fossil salt, as those earths yielded it by elixation, &c. but by far the greatest part of this Eastern nitre is found ready formed on the flat grounds, the great heat of the sun, in those countries, being sufficient to exhale the superfluous aqueous parts, and suffer the salt to crystallize, which wants no other preparation; whereas all the nitre or salt-petre made in *Europe*, requires the addition of some fixed alkaline salt, as *pot-ashes*,

&c. the reason was often before mentioned ; all the earths from which nitre is extracted in *Europe*, are impregnated with animal salts only, which are known to contain no fix'd salt ; a *lixivium* from such earths will yield no other than a *nitro-ammoniacal* salt, which gently evaporated, leaves only an unctuous saline mass, that soon liquifies in the air, but will never crystallize, 'till some fixed alkaline salt is added. The manufacturers of salt-petre are well apprized of this, and for that reason they are always provided with some alkaline substance, ashes of one kind or other ; the nitrous acid, having a greater affinity with the fix'd alkali in the ashes than with the volatile alkali it was before join'd to, quits this to join the other (see tab. of affin.), and by that means becomes that concrete salt, which we call nitre or salt-petre ; the manner of manuring our grounds seems to confirm this change of the *basis* of nitre from the animal to the plant, and *vice versa* ; the animal substances employed for this purpose are known, by their *analysis* to contain a nitro-ammoniacal salt only, which if boiled down by itself, wou'd never crystallize, as was before observed, but upon this salt's passing into the plant, it quits its volatile *basis* to join the fixt one in the plant ; it is this change of *basis* that constitutes this concrete salt we call nitre, and this is that nitre imported from the Eastern countries.

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As to what *Stabl* and others say, that nitre is no more than the universal, primogenial, vague acid, only altered by its combination with the *phlogiston* after a peculiar manner, by the means of putrefaction; a due attention to the following matters of fact wou'd suffice to shew, how little foundation there is for this opinion. 1st, Such plants as are known to contain nitre, taken green out of the earth, manifest upon their incineration, their containing nitre already formed, for they are seen to fuse as considerably as nitre, put on a live coal wou'd. 2dly, animal substances analysed, while yet reeking in their blood, are in like manner known to yield nitre, or rather a nitro-ammoniacal salt, such as wou'd result from the combination of the nitrous acid and the volatile salt of vipers.

By all this it is sufficiently obvious, that in both these cases, putrefaction cou'd never be the productive cause of this nitre. 1st, The plant was calcined while yet green. 2dly, The animal substance was analysed while yet warm, and before it had time to putrefy; putrefaction therefore cou'd by no means be the cause of the change, the universal acid underwent in its passage from the earth into the plant, which constitutes it nitre; it can at most be considered only as the means *Nature*, usually makes use of, to develope and make manifest such salts as lay before concealed in either the
plant

plant or animal analysed, and that by dissipating such superfluous, oily particles as while present, wou'd so envelope this connate, nitrous salt, as to prevent its appearing in its genuine form of nitre.

Shou'd there yet remain any doubt of nitre's being a salt, essentially different from all the concrete salts we know, the following properties, peculiar only to nitre shou'd seem sufficient to remove it.

Nitre whenever combined with other substances, is known to affect, in its crystallization the appearance of some of the twining shrubs, such as the vine, joy, &c. instances of the kind we see in solutions of mercury and silver in the nitrous acid, whence that beautiful metallic vegetation, *Homburg's Arbor Dianæ*. M. Lemery has hit upon as beautiful a vegetation of iron in the same nitrous acid, which no other acid was ever known to do; besides, nitre is known to forward the growth of all plants, whether of the ascescent or alkalescent kind*, while a solution of common salt or alum is found rather to retard than promote their growth.

This property of forwarding the growth of all kinds of plants, peculiar only to the nitre, wou'd seem to evince, that nitre is solely the produce of plants, consequently the nitro-ammoniacal salt, obtained from animals, was first

* See before, p. 78.

first formed in the vegetables those animals took in for their food; this probably being the case, we shou'd not be surprized to see plants, watered with a solution of nitre, thrive apace, all this nitre has now to do is, to re-possess the place it was first formed in, the plant by this means, is exempted from the trouble of manufacturing its own salt; such plants must necessarily upon their analysis, afford nitre in good plenty.

From the whole, we may safely conclude, that all the nitre we know, is obtained primarily from vegetable, and secondarily from animal substances, and essentially different from all the concrete salts we know.

Of the Conversion of Acids into Volatile Alkalies, 1717.

We have explained before (page 3) what alkalies fixed or volatile are, that they are always the product of fire or fermentation, which decompose such bodies as are exposed to their action, that neither existed in that form in either the plant or animal, before these substances were submitted to its action; fix'd alkalies therefore are no more than acids concentrated in a portion of the earth and oil they retained, as the plant or animal substance was burning, and the only difference between the fixed and volatile alkali is this, the fixed alkali contains a good deal of earth, joined to
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a little oil ; the volatile alkali on the contrary, contains very little of earth, but a good deal of the oil of the plant or animal it was had from. It is this oil that renders this salt so volatile, as to rise with the least action of fire ; vegetables in general afford a good deal of a fix'd, but very little of a volatile alkali ; animals on the contrary abound in a volatile alkali, and minerals contain very little of a natural, fixed alkali, such as the *Natrum* of *Egypt*, and some others, had by lotion from some earths about *Smyrna*, and several other Eastern countries. The Chemists have discovered a method to convert salt-petre into a fix'd alkali ; but no one hitherto has been able to obtain a volatile alkali from a mineral acid *, which is a little extraordinary ; for as we see every day the vegetable acids converted into either fix'd or volatile alkalies, why shou'd not the mineral acids be equally convertible into either fix'd or volatile alkalies, seeing the primitive source of all salts is the same, the earth ; these cannot therefore differ essentially from each other.

The better to conceive how mineral acids might be converted into volatile alkalies, we shall first consider how both the vegetable and animal acids are converted into either fix'd or

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* *Neuman* assures us, that *Stahl* upwards of 30 years before, had discovered this method of converting mineral acids into volatile alkalies. See *Lewis's Transl.* p. 204.

volatile alkalies by the assistance of fermentation or calcination.

Every body knows that when we wou'd have the essential salt of a plant, the expressed juice is put into a cool place, to shoot into crystals; but had this same juice been kept in a warm place, it wou'd ferment, swell and throw up a scum, or deposite at the bottom and sides of the vessel, all its coarser earthy parts; the acid, then freed from those earthy parts, extended in the *flegm*, attenuated by the fire, contained in all substances, soon becomes a vinous liquor, not unpleasant on the palate; but had the fermentation been suffered to continue, 'till those particles of fire contained in all bodies, had dissipated the fine particles of oil in the same juices, the acids now left naked, wou'd make as strong an impression on the tongue as vinegar wou'd; all this while, the acid is in a liquid form, and does not become either a fix'd or volatile alkali, 'till it is exposed to the action of the fire; but instead of expressing the juice, had the plant, after it was pounded, been left with its juice in a temperate place, it wou'd soon turn sour, and upon a further putrefaction, a volatile alkaline salt wou'd exhale, disagreeable to the smell; and if this matter had been set to distill, it wou'd yield a good deal of a volatile alkaline salt. The same thing happens to

creme of tartar, and all other essential salts, which never yield an alkaline salt, 'till they have been exposed to the action of the fire; but after tartar has been dissolv'd in water, it soon ferments, and when distilled after, it yields very readily a good deal of a volatile alkaline salt.

What happens in both processes is this: the previous maceration and subsequent fermentation detach the acid from the coarser earthy parts, which joining the oil after, forms with it this volatile salt in question.

This is visibly exemplified by the manner of the fixing of nitre; a pound of nitre is melted in a crucible, placed in a naked fire, to which is added, by little at a time, some powder of charcoal; this projection is continued, while the nitre exhibits a flame, or a detonation ensues; the operation over, the pound of salt-petre will yield from 10 to 12 ounces of a fix'd, alkaline salt. It is here sufficiently obvious that a part of the nitrous acid was, during the above process, converted into this fix'd alkaline salt; for it is known, that a pound of nitre contains half its weight of water, which it took in its crystallization; of the remaining half, 4 ounces are the acid, and the other 4 ounces the alkali; if these 4 ounces of acid were not converted, during the above process into a fix'd alkali, how cou'd

cou'd a pound of nitre yield from ten to twelve ounces of a fix'd salt, as in the above process? here then the nitrous acid is visibly changed into a fix'd salt, nearly in the same manner as a vegetable essential salt is converted into the like fix'd salt by calcination; a portion of the acid in the plant joins, during the calcination a portion of the oil of the same plant, both insinuate themselves into a portion of the earth of the plant, and so form the fix'd alkaline salt.

Hitherto we have only seen the change of a mineral acid into a fixed alkali; this process however, if rightly attended to, will furnish us with a proof of the change of the same mineral acid into a volatile alkali. The vapors that exhaled in the process in the fixing of nitre, evidently shew, that they contain this volatile alkaline salt in question; to be certain of this matter, M. *Geoffroy* employed a tubulated retort, to which he adapted several *ballons*, with double gullets by Chemists called *adaptors*, both to give the matter room enough to expend itself, and to prevent the breaking of the vessels, he placed this retort in a reverberatory furnace, he projected by little at a time, a mixture of equal parts of nitre and powder of char-coal (the quantity of char-coal was here necessarily increased,

to moderate the violent explosion of the nitre, which wou'd otherwise break all the vessels), in the course of this process he perceived, that the vapors that exhaled, thro' the tubulated aperture, had as strong and penetrating a smell as any volatile alkaline salt whatever, after he had projected all the matter he had prepared, he rais'd the fire, to expell what vapors might still remain ; at the end of the operation, he found in the receiver a very penetrating, urinous liquor, of a saltish taste, and transparent, which besides the urinous smell, gave all the other signs of its being a volatile alkaline salt ; it fermented strongly with all acids, it turned syrup of violets green, and a solution of copper blue, it first coagulated, and precipitated after a solution of corrosive sublimate.

As therefore this volatile alkaline salt did not pre-exist in either the nitre, or char-coal, it must be produced during the operation, in the same manner as the fix'd alkaline salt of the plant is form'd, during its calcination ; the nitrous acid joins a portion of the oil in the char-coal, and a little of its earth, and by the action of the fire, they are united, so as to form this volatile alkaline salt in question. A like volatile alkaline spirit might be had from any of the other mineral acids ; a mixture of equal parts of salt of tartar
and

and the flowers of brimstone, melted in a crucible in a naked fire, dissolved after in a sufficient quantity of water, and left in a cucurbit, till it begins to acquire a fetid smell, will by distillation, yield a good quantity of this volatile alkaline spirit; in this process a part of the vitriolic acid joins the alkaline salt of tartar, as having a greater affinity with it than with the *bitumen* it was before joined to in the brimstone, and forms with it a vitriolated tartar, while another portion of the same acid joins the *bitumen*, now highly rarefied, and rises with it in vapors, which contain this volatile alkaline spirit.

Cou'd there still remain any doubt of this conversion of a mineral acid into a volatile alkali, the following process of M. *Bourdelin*, as related by *du Hamel* in his latin history of the Royal Academy, must intirely remove it.

M. *Bourdelin*, took the filings of steel, and made them into balls with water, he exposed these balls after to the sun, adding still more water, while he perceived his balls increased in weight, he then put them into a retort, placed in a reverberatory furnace, from which he obtained a good deal of a volatile alkaline spirit.

By this process it is sufficiently obvious, that the mineral acid was converted into a volatile alkali, the water here added to the filings

lings of steel, dissolved the vitriolic acid, as it did in the preceding process; the fire rarefied the bituminous parts, the sulphur of the same filings, and by the assistance of the subsequent distillation, were so united as to form this volatile alkaline salt.

This same process further informs us, that fix'd alkaline salts differ essentially from each other, equally as volatile alkaline salts do; for the fix'd alkaline salt of every plant naturally preserves the *characteristic* of the acid of the plant it was had from; wherefore as in the following processes, one volatile alkaline salt was obtained from a vegetable acid, and another from a mineral acid, these volatile alkaline salts shou'd not be promiscuously employed, as some Chemists have advanced.

*Of the Volatilization, whether real or apparent,
of fixed alkaline Salts, 1717.*

Before M. Geoffroy had given the preceding account of the experiments he made to convert acids into fixed or volatile alkaline salts, M. Lemery was employed in making such experiments, as naturally led him to discover the same thing; accordingly in 11 days after he read his Memoir concerning the conversion of acids into volatile alkalies, he acknowledges that

that alkaline salts, fixed or volatile, are not to be found in that form in any body, salts in all bodies are in a concrete form, and are rendered alkaline, by being deprived of the greatest part of their acid by the action of fire, whereby they are decomposed, but may be easily regenerated by restoring to them the acid, they were deprived of. We have an example of this in the process of fixing of nitre, and restoring it to its former state by adding the acid the fire had deprived it of.

How M. *Lemery* came to discover this volatilization of acids, he tells us was thus, upon his making experiments with iron, and dissolving it in all kinds of *menstruums*, in the vitriolic and nitrous acid, he filter'd this last solution, and pour'd water on the red *ochery* substance left on the filter; this water came off, one time red, at another time either yellow, or green, which denoted so many different solutions of iron; for *lixivium tartari* pour'd on the first solution of this first *ochery* substance, did not destroy its red color; it only form'd a sort of a red *coagulum*; but the same *lixivium* pour'd on the second solution, turned it in an instant into a green *coagulum*.

M. *Lemery* put some of this second solution into a *cucurbit*, and pour'd a good deal of the *lixivium tartari* upon it, there arose that instant, a prodigious quantity of volatile alkaline

kaline vapors ; he then fitted a head and receiver to it, and observing that the vapors still continued ascending, and willing to know what they were, he took off the head ; he was here so violently seized by the nose, as to be scarce able to withstand the impression ; hereupon he luted the vessels, and set the matter to distill, first by a gentle fire ; and here again he took off the head, to discover the nature of those vapors that ascended ; the spirit took him here by the nose as violently as any other volatile alkaline spirit wou'd ; he now was convinced that this spirit, as to the smell, was as strong as the volatile spirit of sal ammoniac ; upon pouring some of it on a solution of corrosive sublimate, it precipitated it into a white powder, as all other volatile alkaline spirits do.

And here M. *Lemery* adds, that tho' it may appear, that both M. *Geoffroy* and he had discovered the manner of converting an acid into a volatile alkali, yet he confesses he has several doubts on his mind, that what both did, amounts to no more than this, to unfold and make manifest a volatile alkali, which really pre-existed, but lay as it were concealed in such substances as were scarce ever before suspected to contain any, and adds, but let the case be as it will, it must be confessed in horror to truth, however mortifying it may be to both

both of us, that we were not the first, who discover'd this method of volatilizing acids ; *Roussseau* in his book of the secrets in Chemistry p. 56, 57. extracted from copper a volatile alkaline salt. The *caput mortuum* of all the kinds of vitriol, first exposed to the air, and set after to distill, will by the utmost torture of fire, yield the same volatile alkaline salt ; M. *Bourdelin* * obtained the same kind of volatile alkali from the filings of steel, impregnated only with water, and distilled after ; M. *Homberg* obtained the like alkaline spirit and a very fine and penetrating salt from a mixture of 2 parts of salt of tartar and one of alum †. M. *Homberg* did not think he had composed this volatile alkaline salt, he rather thought that it was the salt of tartar that had been volatilized ; M. *Lemery* suspects, that M. *Homberg's* volatile alkaline salt lay concealed in the alum ; for the manufacturers of alum are known to employ urine, to purify it ; we shou'd not therefore be surpriz'd to find a volatile alkaline salt, when alum is employed in experiments of this kind, and even vitriol, without the assistance of the salt of tartar, or any other *intermedium*, is known by the utmost torture of fire, to yield the like volatile alkali ; this wou'd induce one to think, that this volatile alkali in both alum and vitriol, lay there concealed, and in some sense united to

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* du Hamel's hist. p. 219.

† Ibid.

their acid, forming with them a kind of sal ammoniac, which the action of the fire had only detached from them, and set at liberty to manifest itself in its own volatile form ; now as this vitriolic acid from its specific gravity, cou'd not with the same degree of fire, rise either so high, or so speedily as the volatile alkali it was joined to, so it remains with the *caput mortum* in the cucurbit ; but when a fix'd alkali, such as the salt of tartar, is mixed with either vitriol or alum, the vitriolic acid quits the volatile for the fixed alkali, as having a greater affinity with it, forming therewith a vitriolated tartar, the volatile alkali, thus abandoned by its acid, comes over in its own genuine form, like what by the usual process is had from either vegetable or animal substances.

The promptitude with which this volatile alkali rises upon pouring *lixivium tartari* on a solution of iron, for example is, in M. Leme-ry's opinion, a strong presumption, that all that then happens is, to unfold what really pre-existed, a volatile alkali, which is only detached from the vitriolic acid, it was joined to ; for the very same thing happens upon pouring the same *lixivium* upon a solution of sal ammoniac in water, the volatile alkali rises here with the same promptitude as in the former experiment with a solution
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of iron, where it is sufficiently evident, that all that happens is to set at liberty the volatile alkali, we know is join'd to the marine acid, in the sal ammoniac; and probably nothing more happens when *lixivium tartari* is pour'd on a solution of vitriol than to set at liberty the volatile alkali that pre-existed, and was before join'd to the vitriolic acid.

Of Epsom Salt, 1718.

Epsom salt has been for some years past the salt in fashion, particularly in *England*, from whence we have it. It is bitter, and purges gently, in 1697, Doctor *Grew* published a treatise, in which he gives an account of a salt, he had extracted from the mineral spring at *Epsom*; ever since, this salt became greatly in vogue, both in *England* and in other countries; but the *Epsom* salt now imported, is sold at so low a price, that it is not possible it cou'd be had from the mineral spring at *Epsom*; no mineral water is known to yield more than $\frac{1}{18}$ of salt, that is, about a dram of salt to a *Paris* pint of water; add to this, the expence and labor in extracting this salt, which must ever prevent its being sold at the low price our present *Epsom* salt is sold at; consequently our

Epsom salt cannot be Doctor *Grew's* salt, but some fossil salt, or the easy produce of some Chemist, who had the art to give it the name of a salt, already so much in vogue, which was no small advantage to him, as to the sale of it.

M. *Boulduc*, the Father full of this notion, began to consider this salt; at first, he imagined it had alum in its composition; for put over the fire, it wou'd swell and blister, as alum is known to do; accordingly he tortured alum, with all kinds of saline substances; but salt of tartar is what succeeded best with him; for the acid in alum, having a greater affinity with the alkaline salt of tartar than with its own absorbent *basis*, it quits this *basis*, for the salt of tartar, and with it forms a new salt, in color and exterior form of its crystals, like *Epsom* salt. All the difference is, this new salt is not so bitter as *Epsom* salt, and yet it cou'd not be the *Epsom* salt imported, as it cou'd not come to market at any such price. M. *Boulduc's* salt was intirely free from all earthly parts, whereas *Epsom* salt contains a good deal; M. *Boulduc* pour'd *lixivium tartari* upon a solution of *Epsom* salt, which precipitated a kind of a white absorbent earth, as wou'd precipitate from a solution of alum with the same *lixivium*.

M. *Boul-*

M. *Boulduc* believed for some time, that he was the first that made a salt with alum and *lixivium tartari*; but upon examination he found that *Hartman* had long before composed the like salt, which he greatly esteemed. M. *Boulduc* found this salt purged rather better than *Epsom* salt; for this leaves too great an astringency and dryness after it, owing to that great quantity of absorbent earth it contains, whereas *Boulduc's* salt was intirely free from all such earthy parts. *Epsom* salt might be easily depurated, but then this wou'd bring it the dearer to market, which is what he wanted to avoid *.

* It must surprize every body, who reads this Memoir to find so great a Chemist as M. *Boulduc*, the Father really was, so much mistaken in the nature of this new salt, as he imagined it was; to find that sagacious *analyser* of all kinds of substances, overlook one of the most common salts of the shops, or take vitriolated tartar for any other salt; or forget that the aluminous and vitriolic acid were the same; consequently his pouring a *lixivium tartari* upon a solution of alum, shou'd produce the same salt, as if he had employed a solution of vitriol. The greatest men we see, are apt to overlook things.

Epsom salt is a composition of *Glauber's salt*, common salt, and a pinguous *incoagulable* water it took in its crystallization, which keeps it always moist; both these salts may, by an easy process, be had separate; dissolve your *Epsom* salt in water, expose it after in an earthen glazed pan, to be gently evaporated in the air, the *Glauber's salt*, which is in greater plenty, crystallizes first, and is easily distinguishable; oil of vitriol makes no alteration in it. At the sides of the same pan, the common salt will be found in cubic crystals; lastly, the above *pinguous* *incoagulable* water, will be found in the pan, along with the remainder of the water employed to dissolve the salt.

But

But after all M. *Boulduc*'s inquiry, the true composition of *Epsom* salt remained still a secret to him, and wou'd probably still remain so, had not Doctor *Mendez*, Physician to his Majesty, K. *George* communicated to him the manner it is made at *Limington* in *Hampshire*, and at *Portse-Island*, the only two places it was then made in *England*. They boil down the *bittern*, remaining in their salt pans, after the salt is crystallized, and from it obtain this salt, which goes by the name of *Epsom* salt. Doctor *Mendez* sent with the above account, a hogthead of the same *bittern*, that M. *Boulduc* may, by his own experiments, verify the above manner of making *Epsom* salt.

Of *Parmacitty*, 1718.

Naturalists have long believed, that *Parmacitty* was the *sperma* of the whale. M. *Lemery* the Father, in his history of drugs, has set them right, by informing them that it is the brain of the whale, prepared after a certain manner; to this account M. *de Jussieu* adds, that this *Parmacitty* is the brain of such whales only, as have teeth, which kind of whale is not often met with; those teeth weigh from 1 to 2 pounds each.

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We now know whenever *Parmacitty* is found floating on the sea, that it is the brain of some of this kind of whale, now dead, and putrefied, which from the collision of the waves, and heat of the sun, has received such a preparation as is equal to the artificial one.

To prevent the ill Effects of those Vapors that arise in Chemical Processes, 1719.

Those vapors that rise in all chemical processes contain the most volatile parts of the *menstruum* and the substances exposed to its action; and when they are not dangerous, they are always disagreeable. The vapors that arise from dissolutions of copper, lead and antimony in the vitriolic, nitrous and marine acid, but more particularly, from the nitrous acid, are so very dangerous, that it wou'd be great imprudence to expose one self to them, even tho' one took the usual precaution of making those dissolutions either in the open air, or under a chimney.

M. *Geoffroy* the elder, proposes a facile method of avoiding this danger, and which rather promotes than retards the process, and that is to cover the substance to be dissolved with any vegetable expressed oil; this oil absorbs the vapors, and so prevents their rising. M. *Geoffroy* confesses he took the hint from the
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sugar-boilers ; the instant the sugar is going to boil, they throw a little oil on the top of it ; this presently checks the boiling over of the sugar ; the same method is observed in the boiling of honey ; some rub the inner rim of the pot only with soap, which has the same effect.

M. *Geoffroy*'s method is this, he puts the substance to be dissolved into a cucurbit, wetting it first with either water or spirit of wine, to prevent the oils adhering to it, which wou'd retard the dissolution, he after pours the oil, so as to cover the matter to be dissolved, and lastly, the *menstruum*, which easily penetrates the oil so as to reach the substance to be dissolved ; the quantity of oil shou'd be in proportion to the quantity of matter to be dissolved, as well as to the nature of it, whether subject to swell and effervesce, and *è-contra* ; in dissolutions managed after this manner, the bubbles of air are seen to rise, but are as soon seen to disperse themselves in the oil, where they are immediately after lost.

This method has these three advantages attending it, 1st, it effectually secures the operator from the danger arising from those noxious vapors, that always attend the solution of metals in corrosive mineral acids, 2dly, it as effectually prevents the great rarefaction attending

tending those solutions, wherein the matter very often rises over the vessel it is in, and is thereby lost, 3dly, the *menstruum* acts more powerfully on the metal or mineral to be dissolved; the oil repelling the *menstruum*, acting in some sense like the dome of a reverberatory furnace, and by that means a less quantity of the *menstruum* will do.

The oil after the operation becomes thick, owing to the acid, it has imbibed; but by melting it over a gentle fire, it will do again, and shou'd any vapors arise; a little spirits of wine will render them rather agreeable, without interrupting the process. M. Geoffroy has, by the means of the spirits of wine alone, secured himself against those noxious vapors; he pours his spirit of wine gently, so as to float on the top of the mineral acid. This as effectually checks the effervescence as the oil; what vapors do arise, are white, and of an agreeable smell, being no more than a dulcified mineral acid.

Of the Deficiencies of the common Methods of analysing vegetable and animal Substances, 1719.

It was one of the earliest cares of the Academy to appoint *analyses* to be made of several plants; accordingly 1400 plants were analysed in the usual manner, the produce of all of them was nearly the same, tho' the

plants *analysed* were of ever so different a nature. The reason is this, the fire so changes the nature and *arangement* of the component parts of both the plant and animal, that neither retain their true characteristics after their *analysis*; it may therefore be reasonably inquired, why was so much time and expence thrown away on such *analyses*? M. Lemery tells us, that it was necessary to make those *analyses*, were it only to convince us of their insufficiency; nothing else cou'd induce us to lay them aside, so great was the prejudice in their favor; wherefore had those *analyses* no other end than to undeceive us, to enable us to set the just value on them, the time and expence were well bestowed; but to form a right judgment of the change, the fire makes in those substances exposed to its action, let us consider those substances, a plant, and an animal, in their natural state, and compare this state with that they acquire after their *analysis*.

There is in all plants and animals, two distinct substances, which merit our attention, *viz.* an oil or sulphur and a salt; these are far from being *principles*, each being composed of other parts; the salt in both the plant and animal subsists in the form of a concrete salt, which from the number of experiments, M. Lemery made on animal substances, appears to be

be of the nitro-ammoniacal kind, that is such a salt as wou'd result from the union of the marine acid for instance, and the volatile salt of harts-horn or vipers, which is so like nitre, that an acid liquor, in every respect like our common spirit of nitre, might be extracted from it; besides this nitro-ammoniacal salt, animal substances contain some common salt, which is easily extracted from them, but never combined with a volatile alkali, so as to form a sal-ammoniac like the common.

There is more of this nitro-ammoniacal salt found in animal than in vegetable substances, by reason all vegetable substances are known to abound in a fixed alkali, and to contain but very little of a volatile alkali; animals on the contrary, abound in a volatile alkali, and contain very little of a fixed alkali, so that an acid, which in the plant wou'd form such a concrete salt, as wou'd result from the union of the nitrous acid and *lixivium tartari*, wou'd in the animal form such a salt, as wou'd result from the union of the same nitrous acid and the volatile salt of *vipers*. It is for this reason that we find more of the first concrete salt, nitre, in plants, and more of the second kind of salt, a nitro-ammoniacal salt in all animals.

How this concrete salt, a nitre in the plant, becomes a nitro-ammoniacal salt in the animal, and *vice versa*, has been before explained *. Besides this salt-petre and a nitro-ammoniacal salt, plants are found to contain other salts, such as vitriol and common salt; those therefore form different classes of essential salts, which have different properties and effects, according to the species of salts they contain.

Having thus far discovered the Nature of those salts, both plants and animals contain in their Natural state, we are next to consider what change the fire makes in those same salts, after the plant and animal have been *analysed* in the usual manner; and here we are first to observe, that tho' the nitro-ammoniacal salt in both the plant and animal is composed of an acid and a volatile alkali, which are in their own Nature very volatile, yet it does not rise in distillation, as the common sal-ammoniac is known to do. The fire must first disentangle this salt from the other component parts of the plant or animal to be *analysed*; but as the fire is not able to raise all this salt, it first disengages, and raises after the volatile parts only; that is, the volatile alkali of the sal-ammoniac of the plant or animal analysed, and now separated from its acid,

* See before p. 212.

acid, which acid remains with the *caput mortuum*; this is the true reason why there was so little appearance of an acid in the *analysis* of animal substances, that 'till very lately they were judged to contain no acid; such *analyses* necessarily lead us into two errors, 1st, That animal substances contained no acid, whereas it will hereafter appear they contain a good deal. 2dly, That all their salt is a volatile alkali, whereas both the fix'd and volatile alkalies are well known to be the product of fire, and never to be found in that form in either a plant or animal, as hath been often before observed.

But to account why a part only of this nitro-ammoniacal salt in animals, the volatile alkali comes over in the *analysis* of animals, and not both the acid and alkali together, as the common sal-ammoniac wou'd do, when analysed alone, we are to consider, that experience teaches us, that the volatile alkali in most compound bodies is more volatile than the water in the same bodies, and yet in the *analysis* of the viper and other animal substances, the *flegm*, as less adhering to the other parts, mounts first, even before the volatile salt; but when this volatile alkali is once set at liberty, separated from those other substances, that kept it entangled, it then comes over in its own genuine form, a volatile salt.

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Something similar to this happens to sal-ammoniac, when it is alone, unmix'd with other substances, it then rises intire without any difficulty; but when this same sal-ammoniac is in a compound body, intimately blended with earthy substances, it then becomes too heavy for the fire to raise the whole salt, but it disentangles the volatile alkali only, and sends it over in the form of a volatile alkaline salt.

This is sufficiently evident by experience, since by adding a sufficient quantity of an alkaline substance to sal-ammoniac, that salt does not rise entire, as it did when alone; but its volatile alkali only rises, while the acid it was before joined to, unites with, and deeply insinuates itself into the alkaline substance employed, from which it is not to be separated, but by the utmost action of fire. The same precisely happens in the *analysis* of animal substances, the fire disengages the volatile alkali, the *flegm*, and a considerable part of the sulphur or oil in the animal, while the acid remains in the *caput mortuum*; but upon raising the fire, this acid comes over in the form of a reddish acid liquor, as M. *Homberg* discovered*; this liquor, tho' it yields the usual signs of its being both acid and alkali, yet no ebullition or fermentation ensues. M. *Homberg* conjectured that this is owing to the small

* See before, p. 161.

small quantity of *flegm* those salts were dissolved in; but M. *Lemery* conjectures this is rather owing to the sulphurous parts, which by enveloping those acids, so prevent their acting on the volatile alkali contain'd in the same liquor. Was not this the case, it wou'd be difficult to account, why no ebullition or fermentation ensues, when the *flegm* happens to be in a sufficient quantity †.

As therefore in the *analysis* of sal-ammoniac, the decomposition is only in proportion to the alkaline substance employed as an *intermedium*, so from a parity of reason, we have very good right to conclude, why in the *analysis* of animal substances, which are known to abound in volatile parts, the whole of their sal-ammoniac is not decomposed, but remains in the *caput mortuum*, for want of a sufficient quantity of such an earthy or alkaline matter in animal substances to decompose it. What seems to confirm this is, that by supplying this defect, by mixing with animal substances a sufficient quantity of earthy or alkaline substances, a greater quantity of both an acid and

† M. *Lemery* has found that this same liquor, after a certain time, had lost every appearance of its alkaline Nature, owing no doubt to its being saturated with the acid, but that still it appeared to give the same signs of its being acid, on account of a redundancy of those acids, which cou'd not find an alkali to saturate them. This seems to evince that plants contain more of acids than of volatile salts.

and volatile alkali is disentangled, and set at liberty, which without such addition wou'd remain united in the *caput mortuum*. By the help of this *intermedium*, we not only obtain more of a volatile alkali, but also of the reddish acid liquor, which toward the end of the *analysis*, becomes much more sour, and more impregnated with acids than when no such *intermedium* was employed.

For want of such management, no acid cou'd hitherto be obtained from animal substances, tho' they most certainly contain a deal of it.

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A Continuation of the same Subject, 1720,-21.

We are in the next place to consider, what change those salts in the plant suffer in their *analysis*; we before observed, that plants contain more of that concrete salt, nitre than of the nitro-ammoniacal salt; this nitre might be equally decomposed, *i. e.* its acid might be separated from its fix'd alkali, by observing the same method as in the *analysis* of sal-ammoniac with this difference, that as the *basis* of sal-ammoniac is a volatile alkali, this comes over first with the least heat, leaving its acid behind in the retort, whereas the *basis* of nitre, being a fix'd alkali, it resists the greatest action of the fire, and therefore remains in the retort, while the nitrous acid, thus disengaged from its fix'd *basis*, comes over, tho' not with the same readiness the marine acid in the sal-ammoniac does, the marine being much more volatile than the nitrous acid; but the readier to decompose this nitre in the plant, the Chemist shou'd here likewise, as in the former *analysis* of animal substances, employ an *intermedium*, known to have a greater affinity with this fix'd alkali than the nitrous acid has, and such are vitriol and alum; the vitriolic acid contained in those concrete

salts is known to dislodge every other acid combined with those substances it is mixed with; by adding such an *intermedium* to the plant to be *analysed*, the nitrous acid will be dislodged from its fix'd alkali, and being set at liberty, it will come over and manifest itself. It was for want of attending to this circumstance, that all the former *analyses* of plants have proved so little satisfactory; for as in the *analysis* of the common sal-ammoniac, the volatile alkali, being considerably more volatile than the marine acid it is joined to, so the least degree of heat is able to bring it over, leaving the marine acid in the *caput mortuum*: the same precisely happens in the *analysis* of all the alkalescent plants, such as the *cochleria's*, &c. and all animal substances, their more volatile parts come over by the least action of fire, leaving their acid in the *caput mortuum*; whereas were those alkalescent plants and animal substances suffered to macerate for some days before they were analysed, this volatile alkali wou'd have time to disentangle itself from its acid, and being volatile in its own nature, the gentle heat produced by the fermentation wou'd be sufficient to dissipate it; the acid being now freed from its volatile *basis*, wou'd come over, and appear in its own natural form.

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This is further illustrated, by considering the analysis of two plants, the *basis* of one being known to be a volatile alkali, that of the other to be a fixed alkali; the first will yield very little of an acid, while the second will yield a good deal. The reason is this, the volatile alkali in the first plant, being considerably more volatile than the acid it is there united to, comes over with the least degree of fire, affording the usual signs of its being an alkali, by fermenting with acids; but upon increasing the fire, the acid is forced over, and meeting in the receiver its former alkaline basis, it is so absorbed and disguised by it, as no longer to afford the usual marks of its being an acid, its fermenting with alkalies; what happens in the analysis of the other plant is quite different; for as its *basis* is fixed, the acid being more volatile, readily comes over, and gives the usual signs of its being an acid, by fermenting with alkalies; while the fixed alkali remains in the retort with the *caput mortuum*, and which the utmost degree of fire will not bring over.

Now, were both those plants suffered to macerate for some days, the volatile salt in the first wou'd during the maceration, disengage itself from its acid, and being volatile, exhale, leaving its acid at liberty to come over in its own genuine form ; the acid likewise in the second plant, wou'd have time to separate itself from its fixed alkaline base, by which means more of it wou'd come over, and with a less degree of fire, which for want of such management, wou'd still remain with the fixed alkali in the retort along with the *caput mortuum*.

That it is this volatile alkali that envelopes, and conceals the acid, so as to prevent its appearing in the different portions of the analysis of all alkalescent and animal substances, made after the usual manner, is clearly evinced by this experiment of M. *Lemery's*. He found that a dram of the volatile alkaline salt of peach-flowers, which is the strongest volatile alkali known, will require eight drams of the marine acid (for instance) to saturate it fully, whereas a dram of the salt of tartar, the strongest fixed alkali we know will absorb, or take up but two drams and a half of the same acid to saturate it.

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This is further illustrated by the *analysis* of sorrel, which every body knows contains a four juice, of course an acid, of the same Nature of creme of tartar ; but as sorrel contains likewise a good deal of a volatile alkali, this so covers and disguises the acid, that ascends with it in the several portions of its *analysis*, that if this is overlooked, and one suffers himself to be guided by appearances only, he might very naturally conclude, upon examining the different portions of its *analysis*, that sorrel contained fewer acids, or yielded less of them in distillation than other plants, known to contain a great deal less ; but had this sorrel been suffered to macerate for a few days, the fermentation wou'd in that time detach, and expell after this volatile alkali, the acid thus freed from its volatile *basis*, wou'd come over in its natural form.

This is the direct contrary in the *analysis* of lemon-juice, which like that of sorrel is four ; but as lemon-juice affords very few marks of its containing a volatile salt, so upon its *analysis*, its acid readily comes over, and manifests itself in every portion thereof, whereas in the *analysis* of sorrel in the usual way, few acids appear, but in recompence, it is richly impregnated with volatile salts.

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As lemon-juice contains no volatile salt, it wou'd be to no purpose to macerate it, but it is the reverse with such plants and juices, as abound in volatile salts, which, during the fermentation that then happens, disentangle themselves, and so exhale, leaving the acid at liberty to come over in its own form, as was before observed.

There are a great many more plants, which like sorrel, contain a good deal of an acid, but as they also contain a good deal of a volatile salt, this so disguises this acid as to afford very few marks of their containing any such salt.

How precarious therefore wou'd it be to conclude from such *analyses*, that sorrel, and all other such plants contain no acid? it wou'd be no less precarious to conclude that animal substances contained no acid; for was this the case, if animal substances did not contain an acid, it wou'd be impossible to account, what becomes of the concrete salt of such plants, as animals take in for their daily nourishment; for by what has been often before observed, the only change those salts suffered in their passage from the plant to the animal was to exchange their *basis*,
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the fixed one in the plant for a volatile one in the animal; the reverse of this change of basis, from the animal to the plant, was before explained, in the manner our grounds are manured by animal substances*. The acid in the concrete salt in the animal quits its volatile *basis* to join the fixed one in the plant, as having a greater affinity with it. (See the tab. of affin.)

Hence it appears that there is a perpetual circulation of the *universal acid* from the earth to the plant, and from this to the animal that takes it for his nourishment, and from him back again to the earth, in all which, the only alteration it suffers is this change of *basis*, as has been often before observed.

By all we have hitherto observed, it is sufficiently obvious, that it is the volatile salts, diffused through the different portions of the *analyses* of plants, that absorb, and conceal, not only those acids they were joined to in the plant, but also those they were not united to, both which came over with them in the several portions of their analysis. It is likewise as evident, that exclusive of these volatile salts being capable of sheathing the acid that comes

* See before, p. 212.

comes over with them, a good deal of an acid may, and often is enveloped, and concealed in the distilled liquor, by the sulphurous or oily parts of the same plant, which came over with it; wherefore, tho' no acid shou'd appear, or but in a very inconsiderable quantity in those distilled liquors, supposed to be impregnated with a volatile salt, or sulphurous matter, we shou'd not from thence conclude, that such portions of those distilled liquors did contain no acids, or at least, no more than what afforded the usual marks, their fermenting with alkalies.

There are many plants, whose acid and alkali do not always appear disseminated and scattered after the same manner, in the different portions of their analysis; some affords so few marks of their containing any of this volatile salt as may well pass for nothing; in others it does not appear, 'till towards the end of the process; and in others, it appears in every portion from the very beginning, and continues to manifest itself to the very end.

Those plants may very properly be divided into four classes. The first consists of such plants as scarce afford any marks of their

their containing any volatile salt; their acid will appear from the very beginning of the *analysis*, and continue to give the same marks to the end, when it abounds most; because there is here no volatile salt to disguise it; these are Rennets and Colville apples, Dry-martin-pears, Frankreals, &c. /

The second class consists of such plants, as contain more or less of a volatile salt, but it does not manifest itself in the several portions of the *analysis* 'till towards the end; but when this volatile salt does come over, it then compleatly covers and disguises the acid that rises with it, so as no longer to be perceived by the usual trials, tho' from some circumstances, we have very good proof, that even these last portions of the distilled liquor contain more of this acid than any of the preceding ones. Those are the white leaves of the wild and garden succory; periwinkle, chervil beginning to flower, cellery, Roman lettuce, fumitory beginning to flower and seed, the peruvian bark infused in water, gentian-

root, polypody, turneps, rampions, dwarf
sun-flowers, liquorice, violet flowers, of
colts-foot, elder and peaches, roses, artichoke-bottoms, melons, cucumbers, chest-nuts, apricocks, red goose-berries, ripe elder-berries, unripe grapes, buck-thorn, and many others.

The third class differs from the second in this only, that the volatile alkali discovers itself here from the very beginning. As for the acid, it often appears from the first portion, notwithstanding its mixture with the volatile salt that comes over with it; but this acid becomes more manifest towards the end; when the volatile salt begins to appear again, the acid then totally disappears. Those plants are white scurvy, *carduus*, red-beet, spinach, young eschalottes, sage, parsley, flowers of the lily of the valley, heart and other cherries, and many others.

The fourth class differs so far from all the foregoing, that the plants of this class contain, not only more of this volatile salt, but

but this is also more diffused thro' the succeeding different portions of their analysis, in so much, that every one of them gives evident marks of its being impregnated with it; as for the acid, it shews itself more or less in every portion of the *analysis*, in proportion to the quantity of volatile salt it is lodged with, *i. e.* where there is but a small portion of this volatile alkali, there the acid will manifest itself; and *é contra*, where this volatile alkali abounds, it even will cover and disguise it, as hath been often before observed; thus tho' wheat, rye, barley and oats yield in almost every portion of their *analysis*, marks of a volatile salt, yet the acid does not fail to appear also, and that often from the beginning to the end of the process, at which time the volatile salt abounds so much, that it entirely disguises the acid, which is in them. Borrage and Baglafs, which from the beginning of their *analysis*, give strong proofs of a volatile salt, do not discover their acid 'till towards the middle of the process, *i. e.* when the volatile salt begins to be in less quantity. It sometimes hap-

pens, that in one, or two at most of these portions, the acid appears alone, but if it appears afterwards, it is always accompanied with a volatile salt, and that to the very last, in which the volatile salt is found in great abundance, which makes the acid intirely disappear. There are many more plants, which yield in distillation more volatile salts than borragé and bugloss, and for that reason they give fewer marks of an acid than even these, owing to this volatile alkali's covering this acid in every portion of their *analysis*; such are the young and tender leaves and stalks of the white garden orache, radishes, young, tender hop-plants, speckled nettles, pellitory of the wall, colly-flowers, artichoke stalks, gourd-seeds, and several others.

This is further visibly illustrated in the analysis of Roman lettice, which like that of many others, varies in proportion to the age and different parts of the plant; for instance, its root and stalks yield much less volatile salt, and give much stronger marks of acids than the leaves; and the younger
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it is, the more volatile salt it yields, and the fewer marks of acids it affords in distillation, so that we find a very considerable difference between the *analysis* of small, young lettuce, ready to be transplanted into ranks, and that of the very same lettuce, when it is just cabbaged, tender and in its best state for sallad: this plant analysed in these two different states, yields very faint marks of acids, 'till the last portion but one, but yields thro' the whole process a great deal of volatile salt, and the younger still more than the full-grown lettuce.

M. Lemery has here given us a curious process, by which much more of this acid in the leaves of lettuce is obtained than by any other. He directs to express strongly the juice, and put it into a retort, and the bruised leaves by themselves in another; in the distillation of the expressed juice thro' all its stages, a great deal of a volatile salt appeared, and but very few marks of acid, and that only in one portion, whereas the *analysis* of the bruised leaves, being divided into 13 portions, shews no strong signs of

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a volatile salt but in the last, and some slight marks in the last but one, and in the three first, but the acid shewed itself in all the portions except the last, and in several of them, it appeared very evident and in great quantity. By this it is evident, that what prevented the acid, when the infire plant was analysed from appearing, was the great number of volatile salt contained in the juice of the leaves, which being here expressed, the leaves afford the more acid; and even the expressed juice of lettuce, which in its analysis gave so few marks of acids, wou'd by suffering it to macerate for a few days before it was analysed, or by evaporating a good part of it in a bath heat, afford a good deal of an acid.

If therefore lettuce, in which the taste and common *analysis* indicate so few acids, do yet contain, and actually yield a great quantity of them in the different portions of their *analysis*, we might reasonably suppose the same thing of several other plants, which are in the same circumstance with the

the lettuce, with respect to the volatile salts, which abound in their *analysis*, and the quantity of essential salts these plants are impregnated with; for the quantity of acid in every substance is always in proportion to that of the essential (concrete) salt in the same, as will hereafter appear.

By what we have hitherto observed, it is sufficiently obvious, how insufficient all former *analyses* were to discover what plants did contain an acid, and what did not, whereas there is nothing more certain than that there is no plant but what contains more or less of an acid, tho' by said *analyses* it cou'd not be made to appear. We must say the same of all such animals as live on vegetables, which are found to contain a much greater quantity of this acid than even vegetable substances, by reason two thirds of their weight is water only; but as all animal substances are known to abound in volatile salt, this so sheathes the acid, that comes over in the several portions of their *analysis*, as hitherto to be thought to contain no acid.

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The former experiment of M. *Lemery's* satisfactorily accounts for this deception, where a dram of the volatile salt of peach-flowers was able to absorb eight drams of the marine acid.

Now, suppose any given quantity of an animal substance was to be analysed, tho' it was very certain that this quantity of animal substance did contain a certain portion of an acid, yet as all animal substances abound in volatile salts, which in their analysis are known to come over with the least degree of fire, and as according to the foregoing experiment of M. *Lemery*, we know that a dram of this volatile salt is capable of absorbing, of course disguising eight times its own weight of an acid, so tho' the given quantity of an animal substance did, in fact contain a good deal of acid, yet this volatile salt that comes over with it, shall so sheathe and cover it, as to afford no marks of its containing an acid; the Chemist, in such a case, might naturally conclude his animal substance did in
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reality contain no acid. How precarious wou'd such a conclusion be!

But further, in order that this acid, contained in the analysed substance shou'd manifest itself, in the several portions of the analysis, it is necessary that it shou'd be more free, and disengaged in those several portions of the analysis than it was in the very bosom of the compound. We have an instance of this in nitre, which as long as its acid is united to its *basis*, it exhibits no signs of acidity, but when by distillation, this acid is separated from its fixed *basis*, it then becomes sensible; the very reverse happens in the distillation of sal-ammoniac, whose *basis* is volatile, which when set to distill alone, rises then intire, the acid in sal-ammoniac, not being disunited from its *basis*, both are found together on the sides of the bolt-head; but had the Chemist employed the proper *mediums*, the vitriolic acid in the distillation of nitre, to expell the nitrous acid, and the salt of tartar, in the distillation of sal-ammoniac, to retain the marine acid, he wou'd, in the first place, obtain more of the nitrous acid,

and in the next, place more of the volatile spirit of sal-ammoniac.

This is exactly what happens in the ordinary *analyses* of vegetables and animals; for tho' it is beyond dispute that these substances contain a good deal of an acid, yet as many plants and all animals abound in a volatile salt, this so disguises the acid, as upon their analysis not to exhibit any marks of their containing an acid.

The only method therefore to prevent our deception, and at the same time, to obtain a greater quantity of this acid, from either vegetable or animal substances is, first, to macerate them for some time, before they are analysed. By this means, the volatile salt those substances contain, will either exhale, or so far disengage itself from its acid, as readily to come over with the least degree of fire, which by changing the receiver, might be removed, so as to prevent its absorbing the acid, that is to follow. This is exemplified in the distillation of urine fresh-made. Its *flegm* comes over before its volatile salt, nor does it manifest its containing an acid; but when this same urine has been suffered to putrefy, when it
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is analysed after, its volatile salt comes over first, its *flegm* comes next, and lastly a reddish liquor, sensibly impregnated with an acid.

The second method is to add some fixed alkaline *medium* to all such animal substances as are to be analysed, in order to disengage a greater quantity of these acids from their volatile *basis*, so as to enable them to rise afterwards separately, and appear in their own genuine form.

The third method is, to employ, at the beginning of the *analysis*, such a degree of heat only as may be sufficient to bring over this volatile salt, by which means, there will be less of it left to accompany the acid that is to follow; the acid will of course become more sensible.

The fourth method is to increase the fire, and continue it for a long time, and at last to raise it to the utmost degree of violence, in order to detach the acid from its earthy, fixed *medium*. Without this attention, the acid wou'd remain in the retort, consequently, wou'd exhibit few or no marks in the analysis, so as to be distinguished.

Lastly, as soon as the distillation is finish-

ed, the operator shou'd, with all convenient speed, rectify this acid, especially the last portions that came over, in order to prevent the volatile salt it lies confounded with, from covering and disguising it, of course from reuniting with its former volatile matrix.

This method being regularly observed in the *analysis* of animal substances, will extricate the greatest part, if not the whole, of their acid.

As to what regards at present the analysis of vegetables, the most part of their acids being naturally engaged in a fixed *matrix*, when the fire has sent over these acids, they do not find their *matrix* again in the receiver, as the acids of animals do; it is however true, that all the alkalescent plants, as the cochlearia's, &c. yield in their analysis a sufficient quantity of volatile salts, to cover and disguise their acids, but as these vegetables contain less of this volatile salt than animals, and as their sal-ammoniac is always joined with a much greater quantity of another kind of salt, which is not in animals, so these vegetable substances must yield less of this volatile salt in the different
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portions of their analysis than animals; for the volatile salt raised by distillation from an animal substance, has only to answer the acid it was before joined to in the animal, and for that reason, this volatile salt will be more than sufficient to saturate and disguise this acid, whereas the volatile salts raised by distillation from vegetable substances, besides the acids those were joined to in the plant, they are to answer to other acids, contained in a fixed *matrix*, which is the most plentiful source of acids in the vegetable kingdom; wherefore as these volatile salts are not in quantity sufficient to answer and saturate both these sources of acids, so the same process, which wou'd scarcely exhibit an acid in an animal substance, shall be able to manifest it, even in those plants, known to abound most in volatile salts; but whenever it shou'd so happen in the analysis of some alkalescent plants, that this volatile salt is in so great a quantity as to be able to answer both acids, *i. e.* cover and disguise them so as to be no longer perceptible in the different portions of their analysis, which by the bye is seldom the case, by employing the like *medium* as in the analysis of animal sub-

substances, we shall be able to obtain, even from these kinds of plants, a good deal of this acid, which without such management wou'd remain concealed in the distilled liquor.

We shall conclude with some critical reflections on the analysis of plants, with respect to the acids raised from them by distillation; and first, when we consider only the acids, which offer themselves to our view in these analyses, without looking any further, or reflecting that there is always in a plant, concrete and essential salts, known to contain large quantities of acids, such as salt-petre, from whose bosom the acids we now speak of proceed, we might probably imagine, that those acids which the analysis represents to us in a liquid form, disengaged from earthy parts, and sufficiently free, were after the same manner in the plant itself, and not there lodged in a solid matrix, with which they formed a concrete salt.

We might in the next place be led into as great an error, shou'd we estimate the quantity of acids, contained in plants, according to the measure we see them yield in their analysis, and thereby conclude some plants contain more acids than others; how to guard against this deception, has been sufficiently set forth in this paper.

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We shall observe in the third place, that the acids, which have been by distillation dislodged from their fixed *matrix*, do not long remain in that naked state, but as speedily as may be, they possess themselves of other *matrices*, either saline and volatile, or purely sulphurous, with which they form new compounds, so that all those metamorphoses, which are the natural effects of the analysis, must necessarily deceive us, as to the natural order and disposition of the constituent parts of the plant.

Lastly, tho' the analysis of plants evidently manifest their containing acids; yet these acids are so much blended and confounded with other substances, that it is impossible to distinguish their particular character, by which means all plants appear to us to contain one and the same acid.

It is however a matter of some importance to know, and be able to distinguish the particular Nature of the acids of plants, such a knowledge having a great influence towards giving us an insight into their virtues; for it is well known that different acids, lodged in the same *matrix*, form compounds endued with different properties: for example, Natural or factitious salt-petre and vitriolated tartar have the same *basis*, and yet they are known to be possessed of different virtues; mercury dissolved in the marine acid is much more corrosive than when it is dissolved in the nitrous acid.

What

What we here have said of two different acids, lodged in the same matrix, having different effects on our bodies, we may conceive the same of two plants, whose medicinal virtues might be very different, tho', with regard to their analysis, they might not appear to differ in their Nature, or even in the quantity of their acid, and to this difference be accountable, if not wholly, at least in part for their different effects. It wou'd therefore be of the greatest importance to the practice of Physic to discover the particular Nature of the acid in each plant, as such a discovery wou'd greatly improve it.

If to what has been now said of the comparison of the acids of several plants, we add the false Resemblances, which those analyses may represent to us, in comparing the other substances these same plants are composed of, and which, tho' really different in the Natural state of every one of those plants, which are thus compared, do nevertheless appear after the analysis under a like form, this reflection may perhaps enable us to account, how the *solanum furiosum*, a rank poison, and the *brassica capitata*, a wholesome, culinary plant, yield in their analysis, substances so much alike in appearance, that one might very Naturally say, those two analyses were made of one and the same Plant.

Of

from the ROYAL ACADEMY. 265

Of the *Kermes Minerale*. 1720.

It is not always the person, who by indefatigable labor and industry, has discovered some good and useful medicine, that has either the credit or good fortune to procure it that esteem and confidence from the public, it justly deserves ; this depends upon so many necessary and concurring circumstances, that it requires a good deal of time and patience to procure it the good opinion even of a few ; but if thro' chance, any great personage shou'd happen to be ill, and, in spite of all proper means used for his relief, his recovery shou'd be despaired of ; if in some such favorable circumstance, this new and unknown medicine shou'd operate an unexpected cure upon such great personage, especially if his welfare was dear to the people, this alone is sufficient ever after to establish the reputation of such a medicine. This is no where so apposite as to the medicine before us, which for some time past, has gone under the name of the *Carthusian powder* ; Father *Simon*, a *Carthusian Friar*, being the person, who distributed it to all such as called for it, or had any confidence in its virtues. It is true this *Friar* confessed he had it from M. *de la Ligerie*, who owned to Father *Simon*, he had it from M. *de Chastenay*, Governor of *Landau*. This gentleman learned the man-

ner of preparing it, from a *German* apothecary, who had been a disciple of *Glauber* the famous chemist.

How this powder came to acquire this great reputation was thus. In 1713, the above *Carthusian Friar* got some of this powder from *la Ligerie*, to be disposed of, as a specific in most disorders. The *Friar* had it not long, when a lucky opportunity offered to raise its reputation.

Father *Dominick*, a *Friar* of the same order, was seized, in *January*, 1714, with a very violent peripneumony; and notwithstanding he had every thing done for him, that cou'd be thought of, he was almost expiring, when *F. Simon* requested he might be permitted to try his *Specific*, as he used to call it, seeing all hopes of the patient's recovery were now over. His request being agreed to, he accordingly administered this powder, which was attended with so surprizing success, that from that time forward, it daily came into repute. The fame of this surprizing cure soon rung in all *Paris*. Crowds of people came every day for this powder. But what raised its repute to the highest pitch was the following case.

In *December* 1718, the *Marquis de Bayers*, of the house of *Rocheboucault*, was seized with a violent fever, with exacerbations, accompanied with a constant cough, spitting
of

of blood, stitch, oppression and difficulty of breathing. Every thing was done for him, that cou'd be thought off, or is usual in such cases. Notwithstanding, about the 7th day, his belly swelled, and became hard, his spitting was totally suppressed; upon which he had a rattling in his throat, his pulse became low and intermitting, he lost his senses intirely, and was in all appearance a dying.

M. Lemery, who attended this nobleman from the beginning, thought he shou'd be wanting in his duty, both to himself and to his patient, if he omitted to try such things, as might carry a fair probability of success with them; accordingly he proposed to try the *Carthusian powder*, as it was then called, of whose good effects, especially in disorders of the breast and lungs, he was before no stranger, and much less to its composition. M. Lemery confesses, that of all the cases, wherein this powder acquired any reputation, nay, even Father *Dominick's* case, was not near so deplorable as that of the *Marquis's*, nobody, therefore, stood in more need of speedy relief.

M. Lemery, therefore, ordered him 9 grains of this powder to be taken at certain distances; and finding it operated neither by stool, vomit or by the skin, and yet that the pulse visibly mended, and that the oppression was

rather less, he continued the powder, ordering three grains to be taken every 4 hours, which still had no other visible effect than raising the pulse, and relieving the oppression on his lungs, no sensible evacuation whatsoever ensued. The patient remained all this time stupid and senseless, with his belly both swelled and hard, nor did he spit up any thing; however, by continuing the *Kermes* in the above dose for 2 days, he began at last to spit freely, and in pretty good quantity, hard, baked spits, mixed with clotted blood. He continued to discharge those spits for 3 or 4 days successively. From the moment he began to spit, all the former terrifying symptoms began likewise to disappear; he became sensible, the oppression quite left him, and his belly became supple; in short he perfectly recovered. What is very singular in this case, is, that the patient took 36 grains of this *Kermes* in 48 hours, yet it never operated either upwards or downwards, or by the skin, which was contrary to its usual way of acting, even in such cases as were attended with the greatest success.

M. Lemery cou'd not on this occasion, refuse Father Simon a certificate of the good effects of this powder; which, together with another from M. Thuillier, who attended F. Dominick, were both printed, and ever after given *gratis* with the printed bills of its virtues,

tues, to all such as called for them; the same of this powder increasing every day, the King at last purchased the manner of preparing it from *la Ligerie*. He, accordingly, in 1719, published his manner of preparing it. This no sooner appeared, than every body plainly saw, that M. *Lemery*, the Father, had so early as 1706, published the self same thing, the manner of preparing this preparation of antimony, in his elaborate treatise of antimony, and that in a much easier, as well as a more general manner, with any alkaline salt whatever; and at the same time, pointed out the different disorders, where it shou'd be administered; which has been since confirmed by experience, and all this without his being obliged to *Glauber*, or to any body else, for his knowledge of either its preparation or virtue.

M. *Lemery*, the son, who has given the preceding history, did it with a view to restore to his father, the honor of the discovery of this valuable preparation of antimony.

The preparation of *Kermes mineral* from the *Paris* dispensatory. N. B. The operator shou'd first prepare his *lixivium nitri*, q. s.

Take *Hungarian* antimony, broke into small pieces, 4 pounds; filtered rain water, 8 pounds; *lixivium nitri*, 1 pound. Boil in an earthen

earthen glazed vessel, over an even fire, for two hours. Then pour off two thirds of the liquor on the filter; to the remainder add 5 pounds of boiling, filtered rain water, and 12 ounces of the *lixivium*; boil as before, and pour off two thirds more of the liquor on the same filter: lastly, add 5 pounds more of the same boiling rain water, and 8 ounces of the *lixivium*, and boil and filter the whole; mix all those filtrated liquors, let them remain 24 hours, decant after the clear liquor; lay the remaining red powder on a filtrating paper, and by frequent lotions with warm water, edulcorate it; when the powder is well dried, put it into a glazed vessel, adding as much spirits of wine, as will be sufficient to set it on fire: repeat this process once more, keep it after in bottles, close corked, for use.

M. Lemery, the Father, employed *lixivium tartari*, which Lemery the son, thinks is by far more preferable than *lixivium nitri*. For in the first place, *lixivium tartari* is much the stronger of the two, and for that very reason shou'd preferably be employed in preparing the *Kermes*, as it wou'd dissolve more of this sulphur of antimony; besides, as the singular efficacy of this preparation of antimony, consists in its being the least emetic of any of them; so for that reason, it fits easier on the stomach, consequently passes sooner

sooner into the blood, there to display its extraordinary virtues.

M. *Lemery* thinks that what renders *Kermes* so little emetic is its still retaining so much of the alkaline salt, which covers, and as it were sheaths the reguline parts of the antimony, so as to prevent their irritating the fibres of the stomach. The more powerful therefore the alkaline salt, employed in preparing the *Kermes* is, the more of it will remain to sheath its reguline parts, the milder therefore will it be in its operation.

M. *Lemery* assures us, that both in his private practice, as well as in the *Hotél Dieu*, he always found that the *Kermes*, prepared with *Lixivium tartari*, acted both more mildly, and with greater efficacy than what was prepared with *Lixiv. nitri*; nor does he think the burning the spirit of wine on it can add any thing to its virtues, by reason the *Menstruum* here employed is an alkaline salt, which is known to be very little affected by spirits of wine; but it is the reverse in all metallic preparations with mineral acids, such as the *Arcanum corralinum* and others. The superabundant acid, in those preparations, greedily attracts the *Phlogiston* in the spirits of wine, and upon the deflagration, exhales in vapors and flies off with it.

Of the Magnesia Alba. 1720.

This among many others, has been long handed about and passed upon the public for a new medicine. Some artful chemist disguised the *Magnesia alba*, giving it mysterious names, such as *Panacea solutiva*, *anti-hypochondriaca*, *universalis*, *pulvis per excellentiam*. It made its first appearance in *England*, and was there called *Panacea Anglicana*. From *England* it went to *Rome*, where the *jesuits* got hold of it to their no small Emolument; its fame was soon after dispersed all over *Italy*. From *Italy* it made the tour of *Germany* and *Switzerland*, where *Zuingerus* of *Basil* wrote an intire treatise of its virtues; and after all this great noise and bustle, this *Panacea* is no more than an alkaline earth, prepared from the *Mother-ley* of nitre, or the liquor which remains after the crystallization of rough nitre, deprived by lotion of the small portion of nitre or sea salt that might have been retained with it.

This *Lixivium*, or *Mother-ley* as it is called, is set to evaporate in an earthen glazed pan over a gentle fire, till it acquires the consistence of thick honey, the operator taking care all the while to keep stirring the matter, and to scum it. It is put after into a crucible in a naked fire to calcine; when it casts no more vapors, and is become a
white

white powder, it is pour'd into an earthen glazed pan, with warm water in it; this water dissolves what remains of the alkaline salt, in a little time after, the water becomes muddy, and deposits a white powder, which by reiterated lotions is edulcorated, to wash away any salt that the fire had not dissipated; it is laid after on cap-paper to dry.

As an alkaline earth, this powder may be proper to absorb the acid humors in the *primæ viæ*, and correct their acrimony; it may likewise attenuate those humors and gently evacuate the same, without irritation. As a cleanser, it may do service in all glandular infarctions of the mesentery, liver, &c. Its dose is from half a dram to a dram and a half, in either almond milk, *spaw-water*, or *tea*, sweetend if necessary with a little sugar. To expect any benefit from it, it should be continued as long as a course of mineral waters generally is.

M. Boulduc recollected on occasion of this process, that a curious gentleman, and a stranger, had requested of him some 35 years before, to prepare this same *Lixivium*, from which he was to obtain a *Menstruum*, capable of dissolving metals, and even *gold* itself; he evaporated this *Lixivium*, as in the foregoing process; and when reduced to the same thick substance, he added $\frac{1}{4}$ of pipe-

clay to prevent the rarefaction of the matter, otherwise it would infallibly break all the vessels, as M. *Boulduc* experienced the first time to his cost. He put the whole into a coated retort, placed in a reverberatory fire, fitting to it a large receiver, for the matter to expend itself. A very penetrating acid liquor came over, which was rectified in the usual manner, by putting it into a cucurbit, and drawing off as much of the *flegm* as those acids will part with; he pour'd some of this acid on the filings of steel, which were dissolved in an instant. This solution cast forth so fetid and penetrating a smell, that all present cou'd scarce remain where it was. This solution was put afterwards into a coated retort, and had a receiver fitted to it. The spirit by a gradual fire came over, and when no more wou'd come, he then had the fire increased to the utmost degree. Flowers of a beautiful red color soon after sublimed at the neck of the retort; these flowers withdrawn, he had the above spirit put back on the remaining mass in the retort, and as much of it drawn off as wou'd rise, by a gentle heat; after this he had the fire increased as before, and the same beautiful flowers sublimed. The same process was repeated, till no more flowers would sublime. The matter in the retort was like *wax*, and wou'd melt like *ice* in water; those flowers
were

were dissolved after in some of the acid spirit, and by distillation, a spirit of the color of sulphur was drawn off; part of this spirit was evaporated over a gentle fire, and there remained a most beautiful tincture of *mars*, of a fine red color, which this curious gentleman assured M. *Boulduc* was equal to the tincture of *gold*.

M. *Boulduc* had another manner of preparing this same *Magnesia alba* communicated to him, which is by pouring near equal parts of the *Lixivium nitri* on the *Mother-ley*. At first no change happens, but in some time after, the mixture becomes somewhat like butter, on which he pours warm water, it turns milky, which in some time after deposits a white powder, like the former, which is to be edulcorated in the usual manner.

M. *Boulduc* observes, that this second *Magnesia* contains more of the acid of the *Mother-ley* than the former; because the fire in the former process, had intirely dissipated it; but had there been a greater proportion of the *Lixivium nitri* employed in this second process, probably it wou'd absorb all the above acid; but to remedy this inconvenience, M. *Boulduc* calcined this second *Magnesia*, as in the former process, which deprives it intirely of all its acid salt.

Of the essential Oils of Plants. 1721.

Oils in general are of 3 sorts, the first is either by expression, as olive, almond, linseed, nut oil, &c. or by coction, as the oils of bays, laurel, *cacao*, &c. the 2d is by distillation in water, and is called the essential oil of the Plant; it is also called the essence of the plant. The 3d is likewise had by distillation in a reverberatory fire, the oil here is blended with all the other parts, but is after separated and rectified in the usual way.

All the liquid balsams, as the balsam of *Judea*, *Capivy*, *Canada*, and others are ranged among the essential oils; they all by keeping become resins, as they lose their finer parts, such are *storax*, *benjamin*, and some others; but when those essential oils are blended with the sap in the tree, they then form the gum-resinous substances, such as *myrrh* and many others.

This essential oil is contained in the root only of some plants, and in the fruit or seed of others; in many a part only of the root, flower, fruit or seed, are found to contain it; violet-leaves, for example, have no smell, while the flowers are known to have a very fine smell, and to contain a very fine oil; no part of the *jeffamine* tree, except the flowers contain this oil. It is the same with many others, as with the *jonquil*, *clovegilly-flowers*, those of
the

the *Linden-tree*, the *pink*, the *lilly*, and many others, which contain this fine etherial oil, which soon exhales, and on that account they yield no oil, but a pleasant water by distillation. It is the reverse in all flowers of the stone fruit trees; besides a pleasant water, they yield a good deal of an essential oil, and particularly the flowers of the *peach-tree*. These afford more of this oil, and a more pleasant water than any flowers of the same tribe. The rind of most stone fruit contains more of this oil than the pulp. The *macis* more than the outer shell, which contains the nutmeg. Some plants afford more of this oil when young, before their seed appears; others after; others contain more in their *petals* than in their flowers. The season of the year whether wet or dry makes a great difference, both in the quantity and fineness of this oil; *thyme* will afford more of this oil, when the seed is ripe, than at any other time, which oil is found to be the most caustic of any.

The common method of obtaining the essential oil of all plants is by distillation in water. The water macerates and opens the ligneous parts of the plant, those cells which contain this oil; the fire rarefies this oil, and raises it after along with the water in its genuine unaltered state; water cannot dissolve, of course cannot alter oil, the oil is separated after in the usual way.

Where

Where these cells that contain this ethereal oil are visible, as in the peels of *oranges*, *citrons*, *bergamots*, &c. expression alone will obtain it. The *zests* of those fruits are what afford those essences, that are brought to us from *Italy*; in those our cold climates the manner to obtain this fine oil, is to rub the *zests* on a loaf of fine sugar, the sugar imbibes this fine oil, this layer of sugar is scraped off, and more *zests* rubb'd on, whilst the sugar will imbibe any of this oil, this sugar is put after into bottles, and employ'd for the same uses the essences are.

All essential oils lose by keeping both their finer parts and flavor, and acquire that of turpentine, and if longer kept, will become thick and resinous; when this happens, they must be rectified, *i. e.* extended in a good deal of water and distilled over again.

But to remedy this inconvenience, M. *Geoffroy* the younger, recommends to macerate the root, plant, &c. in spirits of wine. His method is to put his *zests*, &c. into a cucurbit, on which he pours spirits of wine; he leaves them for some time in digestion, taking care to stop his cucurbit close, he after fits the head and receiver, and distills them in MB. The spirit of wine, during the time of digestion, extracts this fine essential oil, and comes over very readily with it, and may be easily separated from it after.

M. *Geoffroy*

M. *Geoffroy*, has contrived a *syphon* of a particular construction, which separates those essential oils, more perfectly than those before in use. The two branches of this *syphon* are soldered at right angles; the under branch has near the angle, a ball fixed, not unlike the ball of a thermometer; when both branches by suction, are filled with both the spirit and oil, the spirit is suffered to run off, the essence remains in the ball, free from any mixture. This spirit shou'd be kept to serve again; for as it has imbibed as much of the oil as it cou'd retain, so it will imbibe no more in any future process.

This essential oil has the advantage of that obtained after the common method, 1^o. it is by far more pleasant, and better rectified, it will not so soon lose its flavor by keeping. M. *Geoffroy* has some obtained after this method, which in 8 years after retained the flavor it had at first.

This method will in like manner rectify those *empyreumatic* oils, the spirit will more perfectly separate the gross parts than the water can; besides, the spirit will rise with a much less degree of fire than water; consequently it will bring over with it the finer parts only of the oil.

M. *Geoffroy* in another memoir, 1728, confesses, that spirits of wine are the fittest to rectify oils, where they are in good plenty;
but

but he has found that the spirit retains some parts of the oil, in spite of all care for that purpose, therefore when it is necessary to rectify those essential oils, that come dear to market, he wou'd recommend to employ warm water alone ; for this purpose, he suspends his cucurbit in MB, fits a head with a refrigeratory and a receiver, the water being incapable of dissolving the oil, there is no loss on it. In the bottom of the cucurbit he finds a thick substance, which has retained all the *empyreuma* of the oil.

Of several saline vegetations. 1722.

M. *Petit* *, who has given this account of those saline vegetations, considers them only as so many saline crystallizations. Those salts as they ascend in their crystallization, imitate some known figure of a plant, tree, rock, &c. whence this Name. M. *Homborg*, making some experiments in 1699, with a solution of silver, happened first to discover this kind of metallic vegetation, which he called his *arbor Dianæ*. M. *Lemery*, the son, making some experiments with the filings of

* This year, M. *Petit*, formerly physician at *Namur*, was admitted a Member of the Royal Academy, and pensioner in anatomy, in the place of M. *du Verney*, who desired to retire as a veteran. Now, as there was one *Petit*, a surgeon, before a member of the Academy, to avoid confounding one with the other, I have all along added surgeon to the one, and Mr. only to the Physician.

steel in the nitrous acid, in 1707, he happened to hit upon the like vegetation of iron *. M. *Petit* has here tryed, how far salts are capable of the like vegetations ; he accordingly employed double refined salt-petre, crystal mineral, sal ammoniac, *sal de duobus*, sea-salt ; he dissolved those salts in white and red wine, in lime-water, in different spirits, and in common water. The vessels he employed were glass, china, common earthen-ware and pewter. He observed these vegetations succeeded better in fine china cups, than in common earthen-ware ones ; in glasses better than in china ; and in pewter the worst of all. He likewise found, that any particles of iron, or even stirring the solution with an iron *spatula*, prevented the vegetation ; the earliest saline vegetation is not formed in less than 2 days ; one of the speediest, and at the same time the most beautiful, is that of *sal duobus* in common water, especially when made in a glass goblet.

Sal ammoniac dissolved in either Burgundy or Champaign, imitates, in its crystallization, bunches of grapes ; but both it and salt-petre vegetated better when dissolved in common water, than in wine ; and each did better in white than in red wine ; besides, common water dissolved more of these salts, and *aqua calcis* as much as com-

See Plate IX.

mon water. Alum and vitriol wou'd not vegetate in any liquor M. *Petit* employed, nor wou'd sea-salt vegetate, except when dissolved in the oil of vitriol.

The mechanism of all those vegetations is no more than this ; those solutions of salt exposed to the open air, lose in process of time, a part of their solvent, which evaporates by the heat of the sun only : as the water exhales, it carries along with it some particles of the salt, part of which adhering to the sides of the vessel, those solutions are made in, serve the succeeding particles as a *planum inclinatum*, by which means others ascend, the pressure of the atmosphere contributing nearly in the same manner, as it does to the ascent of the water in a tube, plunged into a basin of water ; thus one particle of salt follows another, till the whole has vegetated, till all the salt in the solution is crystallized ; the first crystals formed in the bottom of the vessel contributing a good deal to the ascent of those that are to follow *.

A natural Verdigrise. 1723.

All the verdigrise we employ is artificial, a recrement or rust obtained, as was heretofore believed, by stratifying copper-plates with the *marc*, or pressing of grapes, where

See Plate XI.

they

they are left in maceration, till they are covered with this green rust; this is after scraped off, and the copper plates put back again, till they are intirely converted into this green rust *.

What

* M. Montet of Montpelier, has, in 1750 given a minute detail of the manufacture of verdigrise in that city. He there tells us, that it is the ligneous stalks the grapes hang to, and not the skins and grains of the grapes, that are employed in this manufacture, contrary to what some chemists have advanced. Some therefore pick those stalks before the grapes are pressed; others carefully separate them from the *marc*, or pressings of the grapes, and carefully dry them in the sun, avoiding their receiving any wet, which would prevent their rendering the wine sufficiently acid to corrode the copper; those stalks are steeped after in a full bodied wine for 8 or 10 days; about this time they emit a strong, penetrating smell, which is the *criterion* of the wine's being prepared to corrode the plates; those are accordingly stratified with the grape-stalks, these forming the lower and upper stratum. The vessels are now covered close for 3 or 4 days, and sometimes longer, some copper yielding its rust sooner, some later. The Plates are 4 inches long by 3 broad; if they are new, they are buried in verdigrise for 24 hours, then heated a little in the fire, before they are put into the vessels. Experience has taught the makers, that by this management, they are more speedily converted into this recrement. The plates are now taken out, and laid one over another to drain, and piled after on their edges to dry; their edges are moistened after 3 several times, by which the verdigrise is nourished, as the makers term it. When the plates become dry, this rust is scraped off, and exposed to the sun to dry, and put after into alum-leather bags for exportation.

N. All those processes are made in wine-vaults, the air being there highly saturated with acid vapors, hastens the formation of this recrement.

Eight ounces of this rust exposed for 3 or 4 days to the sun, lost half its weight; put after into a retort, placed in a sand-heat with its receiver, yielded $2\frac{1}{2}$ ounces of a concentrated acid, of a strong, disagreeable smell. What remained in the retort,

N n 2

being

What was this year imported from *China*, was a natural verdigrise, of a much brighter color than our artificial one, with a fine downy-cast, imitating in its structure, the above saline vegetations. M. *Reaumur* concluded, 1^o. from its weight that it must be a metallic recrement. 2^o. From its color, that it must be *copper*, tho' imperfect, not thoroughly come to its maturity, as was evident by this simple process. He put some of it into a crucible, surrounded with powder of charcoal, which it quickly attracted, and by that means became perfect copper; it is in this only, not having the necessary *phlogiston*, that this natural verdigrise differed from the artificial, which wants no *phlogiston* to recover its metallic form; for the copper in the artificial verdigrise is in no sort decomposed; so it is easily established and restored to its former metallic state.

And here it is very visible, had this natural verdigrise penetrated some transparent stone, it wou'd become a fine *emerald*. Probably all those precious stones are formed by some such matter's penetrating them, by which they acquire those various shades, in which consist their beauty.

being fluxed with equal its weight of the black-flux, in a crucible with its cover on, yielded 1 ounce 2 drams of pure copper, so the 8 ounces employed may be said to contain 1 ounce, 2 drams of copper; the other 6 ounces, 6 drams were made up of the acid, *phlogiston* and *flegm* of the *menstruum*.

Of

Of the salt of Lime. 1724.

We are not, it seems, to despair of any thing in *chemistry*. To assert that lime contained a salt, has been long looked upon as a *paradox*, or at best, a *non ens*. M. Lemery, the father, in his chemistry, confesses he never cou'd discover a salt in lime; yet M. du Fay has been able to demonstrate it: the method he took was this. He calcined anew the common quick-lime; when it was red hot, he put it into a bucket of filtered rain water, that had been before made warm for that purpose; he boiled this lime and water together for $\frac{1}{4}$ hour, and while it was yet boiling, he carefully decanted the clear water into several earthen pans, where he let it remain as long as he liked; he here again decanted the clear water, carefully avoiding any of the lime's going with it; he evaporated this water after, and by that means obtained this salt of lime; common water may be employed; but by employing distilled rain water, you have more salt.

This salt will ferment with all mineral acids: it will also deliquiate in the air, or in the vault, as salt of tartar is known to do.

It was objected to M. du Fay, that this salt was owing to the acid salt in the wood-coal, employed in the second calcination of the

the *Lime*. To this he replies, if the acid of the charcoal in the second calcination, cou'd penetrate the lime, it shou'd likewise penetrate it in the first calcination, when it converted the stone into lime; yet if a salt was extracted from this lime, it would be then looked upon as the salt of lime; and the same shou'd be said of this salt of lime, after the second calcination, which is equally the salt of lime, and not owing to the acid in the wood or charcoal employed in the 2d calcination of lime.

A further inquiry into the nature of Lime.

Notwithstanding the frequent use made every day of *lime*, both in chemistry and medicine, it is plain, by what the greatest chemists have hitherto said of it, that its nature is little known. Some deny it contains a salt, Messrs. *Lemery* the father, *Fr. Hoffman*, *Fickius*, all confess they never cou'd extract a salt from it. *Zwelfer* is of the same opinion: He says, *ex ipsa calce viva sal extrahere conatus fui, utpote de quo chimici multum falsò tamen gloriantur, sed irritò conatu, &c. Pharm. August.*

Others contend it contains a salt, but differ about the quality of it. Some will have it a fix'd, others a volatile alkaline salt, others again will have it to contain both an acid and a fixed alkaline salt. *Vanhelmont* is
at

at the head of these. *Sunt in calce duo Jalia, unum lixiviale alkali, et alterum accidum. De Lithiasi, Hartman, Etmüller, and most chemists subscribe herein to Vanhelmont.*

Ludovicus will have it to contain, besides an acid and a volatile alkali, a concrete salt of the nature of *nitre*; others, in fine admit of a salt in lime, but confess they were at a loss to determine what kind of salt it was. This contrariety of opinions induced *M. Malouin*, in 1746, to make several experiments with lime, lime-water, and the *crust* it throws up, after the lime-water has stood a while. He has, by frequent lotions with boiling water, totally deprived lime of this *crust*; he calcined it anew, to see whether it would yield any more of this *crust*, but found it wou'd not; we shall give here a succinct account of these experiments.

His first experiment was to mix lime with the mineral acids, and draw off these acids after; he observed that they acquired a more penetrating smell than they had before. The vitriolic acid distilled with lime, became volatile, acquired somewhat of an urinous smell, owing no doubt, to a *bitumen*, which is contained in lime. *M. Malouin* obtained something like this from the sediment of the *Plombieres* water*.

See the *analysis* of those waters in Vol. III. p. 334.

after,

He put some quick lime and sea salt into a crucible, placed in an open fire, which produced a bright blue flame, and exhaled an aromatic vapor; this suggested to him, that lime must contain a mineral sulphur.

Upon putting salt of tartar to lime-water, a gentle fermentation ensued; when it was over, what precipitated, after it had been filtered, evaporated, proved to be a vitriolated tartar; to vary the experiment, he employed *kelp* in powder; here also ensued the same gentle fermentation, and what precipitated was found to be a *Glauber's salt*.

These 2 processes evidently prove that lime-water contains a vitriolic acid, which with the salt of tartar, formed a vitriolated tartar, and with the alkali of *kelp* a *Glauber's salt*.

As M. *Malouin* suspected lime contained a mineral sulphur, so he made several experiments to discover this sulphur, by forming with the *cream* or *crust*, lime-water is known to throw up, and salt of tartar, a true *hepar-sulphuris*. And for this purpose, he took 2 parts of salt of tartar, 1 of the *crust* of lime-water, and one half of the powder of charcoal.

He in like manner made a *hepar sulphuris* with the vitriolated tartar he obtained from lime-water, salt of tartar and the powder of charcoal, of each equal parts; this mixture
he

he fluxed in a crucible, dissolved it after in boiling water, filtered, evaporated to *siccity*; till the *fetor* was exhaled; he put this matter after into a crucible, placed in an open fire, where he left it, while it exhaled the odor of sulphur, he dissolved it after in boiling water, filtered and crystallized it, and had the same vitriolated tartar he employed, diminished only in its weight, with which he cou'd form a *hepar sulphuris* as before.

All these experiments manifestly prove, that lime contains a vitriolic acid; but do not declare what is the nature of the salt in lime. To discover the genuine salt of lime, M. Malouin made a 3d *hepar sulphuris* with animal fat, in the place of the powder of charcoal, fluxed it as before in a crucible, dissolved it after in boiling water, filtered it, and poured the vitriolic acid drop by drop into the solution. The vitriolic acid detaches the alkaline salt from the sulphur, which is here precipitated; he filter'd the clear liquor, evaporated it after over a gentle fire; he found at the bottom of the pan extremely fine, brilliant crystals, a true *ferulenic* salt, which is the genuine salt of lime, which no body hitherto suspected it contained, no not even since this salt was discovered in the ferruginous and other mineral waters.

M. *Malouin* observed that this selenitic salt required 10 times as much water to dissolve it as it required to keep it first dissolved; for as much selenitic salt as may be extracted from a *Paris* pint of mineral waters, for instance, will require 10 *Paris* pints of water to dissolve it. And here it is worthy our notice, that tho' this of all the salts is the most difficult to be dissolved, yet of all salts it crystallizes the soonest. It dissolves with more difficulty than crude tartar, as this does than vitriolated tartar, and this last than sea salt; but these salts crystallize sooner in the same order, as they are more difficult to be dissolved. The Experiments M. *Malouin* has made with this selenitic salt, has enabled him to recommend it as an operitive, and very useful in all hypochondriac and hysteric cases. He has also experienced its anodine qualities, in some cases he found it more effectual than the *sal sedativum*, and its effects more lasting.

M. *Malouin* has given it from 2 to 24 grains for a dose; this salt is very light, this it has in common with the *sal sedativum*; he sometimes orders a cooling powder, made with this selenitic salt, (in the place of vitriolated tartar) with nitre and *Cinnabar*, to which he sometimes adds the *magnesia alba*,

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alba, or *coral*, as the several circumstances may require.

It is more than probable that the good effects of mineral waters, in the removal of several rebellious, chronic disorders may be owing to this salt; and as to lime-water, its good effect on the human body is intirely owing to it.

A natural Glauber's Salt. 1724.

This salt was discovered in a small source about 3 leagues from *Madrid*, which runs eastward; about a quarter of a league above this saline spring, there is a vitriolic spring; and a little higher up, a ferruginous one, all in the same line with this saline source. On the borders of this source are found crystals, not unlike those *icicles* seen in winter.

M *Boulduc* analysed this salt, and by every trial he made, it is a true *Glauber's salt*, as will more manifestly appear, by comparing the sensible and others, the known qualities of the factitious *Glauber's salt* with the natural. The factitious *Glauber's salt* leaves a coolness on the tongue, mix'd with a bitterness, both which impressions remain some time; the Spanish salt is found to make the same impressions on the tongue.

The factitious is very friable, more so than vitriolated tartar, so is the natural.

The factitious dissolves readily in cold water, so does the natural, which neither vitriolated tartar, nor any of the other concrete salts will do, they requiring warm water to dissolve them thoroughly.

The factitious by means of the least heat melts, becomes a limpid fluid, and by increasing the fire, is converted into a saline *calx*; the natural treated in the same manner, exhibits the same appearances.

The factitious loses near $\frac{2}{3}$ of its weight in its calcination; the natural loses the same weight. This is only the water both took in their crystallization; both salts put on a live coal, they melt first, and become after a white *calx*; vitriolated tartar would decrepitate, and spread about in small *lamellæ*, but would never become a *calx*; both salts, exposed to the open air, calcine, and are covered with a white *farina*, which destroys their transparency; but upon wiping of this *farina*, the remaining crystals recover their transparency.

Glauber's salt calcined either in the fire or in the air, is known to coagulate 3 times its weight, either of water or ale, the Spanish salt calcined, will as speedily do the same; for by pouring this salt into ale, this is coagulated in an instant, in so much, that if the vessel was turned upside down, not
one

one drop of the ale wou'd fall out of the vessel.

Glauber said his *sal admirabile* wou'd dissolve iron, *M. Boulduc* made the same trial with the Spanish salt, and found it did dissolve iron, and that in proportion as it dissolved the iron, a fine *crocus martis* precipitated.

If one mixed equal parts of *Glauber's salts* and nitre in powder, the mixture soon imbibes the moisture of the air; the Spanish salt mixed with nitre will do the same. So far both salts resemble each other in their exterior qualities. *M. Boulduc* proves that the acid in both salts is the same, the vitriolic acid.

It was long the opinion of chemists that there was no separating the vitriolic acid, when once united to a fixed alkaline salt, as in vitriolated tartar, *sal polychrest*, &c. 'till *Stahl* proposed this problem, *To separate in an instant the vitriolic acid in vitriolated tartar*. One way to effect this separation of the vitriolic acid, is to transfer it to another basis; this method *M. Bulduc* employed, he poured a solution of vitriolated tartar on a solution of silver in the nitrous acid, the instant those solutions are mixed, the vitriolic acid quits the alkaline basis in the vitriolated tartar to join the silver, and precipitates with it to the bottom of the vessel; the

the nitrous acid now at liberty, seizes the alkali of tartar, and forms with it a true nitre regenerated, it fuses in the fire, &c.

M. *Boulduc* makes use of the same method to separate the vitriolic acid in both the factitious and natural *Glauber's salts*.

He divided a solution of *mercury* in the nitrous acid between 3 glasses; to the first he put a solution of the Spanish salt, to the 2d a solution of *Glauber's sal admirable*; both solutions precipitated in an instant the *mercury* in the form of a white *calx*. He poured off the clear liquor, evaporated it after, and had cubic crystals, which would fuse on a live coal, as nitre does; he poured warm water on both precipitates, which became a *turpethum minerale*; he also poured oil of vitriol into the 3d glass; he had here the same precipitate with the 2 former, and with warm water a *turpethum minerale*.

With the same salts and the oil of vitriol he made several other experiments. With the solutions of *saccharum saturni*, and verdigrise in warm water, with tin, in *aqua regia*. The precipitations were alike in every one as in these solutions of *mercury* with the same salts.

By all these experiments it appears evidently, that the acid in the *sal admirable* and Spanish salt is the same; and from the Spanish salt's precipitating an equal quantity of the above solutions, it appears it contains,

tains, in equal weight, as much of the vitriolic acid, as *Glauber's salt*. But to put this matter beyond all doubt, M. *Boulduc* made a mineral sulphur with each of his salts.

For this purpose he took 6 ounces of each these salts, and an ounce and a half of the powder of charcoal for each 6 ounces of salt, he put this mixture into separate crucibles to flux. The matter in each crucible, soon exhaled the odor of *hepar sulphuris*. He dissolved this mass after in warm water, which cast forth the odor of rotten eggs, he divided this solution equally among 3 glasses, into the first he put the nitrous acid, into the 2d the marine acid, and into the 3d, the oil of vitriol. Upon the admixture of these acids, an effervescence and heat ensued. The above odor exhaled from every one of them; and each left an equal portion of sulphur in the bottom of the vessel, in every appearance like common sulphur. Seeing the Spanish salt produces the same kind of sulphur, and in the same proportion as *Glauber's salt*, there can remain no doubt, but the acid in both is the same, and in the same proportion.

All that now remained to prove these salts the same, is to examine the *basis* of the Spanish salt, to see if it be the same with that of *Glauber's salt*. M. *Boulduc* takes the above

bove clear liquor, after the sulphur had been precipitated, and evaporating each solution apart, considers the nature of the salts he obtains. Into the first solution he poured the nitrous acid; the concrete salt left after evaporation is a nitre, of a quadrangular form; into the 2d he poured the marine acid, which in like manner yielded a regenerated marine salt, in cubic crystals; into the 3d solution he poured the oil of vitriol, which produced a *Glauber's salt*, like what is every day made in our laboratories, with the same oil and decrepitated marine salt.

The solution of the *basis* of the Spanish salt, after the sulphur had been precipitated, treated in the same manner, yielded the same kind of concrete salts, which proves evidently, that the *basis* of both the Spanish and *Glauber's salt* is exactly the same.

M. *Boulduc* employed another method to prove the same thing; he took the regenerated sea salt, formed with the *basis* of the Spanish salt and the marine acid, dissolved it after in the nitrous acid. The nitrous acid expelled here the marine, and taking its place, forms with it a quadrangular nitre; he dissolved this quadrangular nitre in the oil of vitriol, the nitrous acid is also expelled in its turn; the vitriolic acid joins the *basis* of the Spanish salt, and with it forms a true factitious *Glauber's salt*, or rather

ther the Spanish salt is hereby regenerated. This experiment evidently proves this Spanish salt to be a *natural Glauber's salt*.

In 1727 as some miners were digging for copper ore near *Grenoble*, in *Dauphiny*, they happened to observe among the earth small brilliant crystals, which they soon discovered to be a salt; when they had dissolved those brilliant crystals in water, and evaporated them after, they flattered themselves that they had discovered a valuable treasure, a fossil nitre. The crystals of this new salt having a faint resemblance of those of salt-petre, is what imposed on them, as it did on many before them.

M. *Boulduc* examined this salt, and made the same experiment with it he before made with the Spanish, comparing it with the factitious *Glauber's salt* of the shops, which is needless to repeat here. But the result of them was, that this salt of *Dauphiny*, is a genuine *Glauber's salt*, and exactly like the Spanish salt.

Glauber, a German chemist, published the method of making this concrete salt, about the middle of the last century; *Kunckel*, in his *Laborat. Chymic.* affirms it was known in the electoral house of *Saxony* upwards of 100 years before. We are however indebted to *Glauber* for the discovery of the composition of this salt, which from some ex-

traordinary success it had, he gave the epithet of *admirabile*. This much is certain, that neither *Glauber*, nor any body else had any notion of its being a fossil salt, or to be found in the bowels of the earth; but the contrary is here fully demonstrated *.

This natural *Glauber's salt* is the *nitrum calcarium* of *Lisler*. It is found mixed with our common *Epsom salt*; it is the pretended nitre of most analysers of mineral waters, as appears by the figure of the crystals they themselves give of them.

M. *Boulduc* found the same salt in the ashes of some plants.

Fr. *Hoffman* has extracted from a mineral water, a bitter purging salt, exactly like the former, a true *Glauber's salt*, easily convertible into a *hepar sulphuris*. A pound of this water yields 2 drams of salt; this salt therefore found in *Dauphiny* is a genuine and natural fossil *Glauber's salt*, even more perfect than the factitious salt of the shop; it will not imbibe the moisture of the air. 2°. It makes no alteration in the tincture of *Turnsol*, nor 3°. will it suffer any change from the oil of

* M. *de Mars* sent in 1732 from *Constantinople*, a fossil salt found in *Egypt*, which he believed was the *sal ammoniac* of the ancients, but upon examination it was found to be a genuine *sal Glauberi*. By this we learn that this salt is found naturally in *Egypt*, as well as in *Dauphiny*, *Spain*, *Germany*, *Hungary*, and in all the waters of the sea.

vitriol, as the factitious Glauber's salt is known to do, owing to some sea salt sometimes joined to it thro' the neglect of the Chemist in not washing it away.

How bottles came to foul the wine put into them. 1724

Upon complaint made to the government concerning these bottles, M. Geoffroy the younger, was ordered to examine what cou'd be the reason of their spoiling the wine. As he cou'd not see the materials, of which these bottles were made, he pounded some of them and poured the nitrous acid upon the powder. The mixture grew considerably warm, exhaling red and fetid vapors, as all metallic solutions are known to do, while the glass of other bottles treated in the same manner, produces no such vapors. When he put whole pieces of the same bottles into the nitrous acid, they became white, and as soft as glue put into warm water, some mucilaginous *lamela* wou'd sometimes separate from them; all the mineral acid spirits had the same effect upon them.

From these experiments M. Geoffroy conjectures, that there was alum in the sand, employed in the manufacture of those bottles, the vegetable acid in the wine dissolved this alum, which is what rendered the wine foul.

M. du Fay, in 1727, willing to inform himself of the true fault of said bottles, conjectures it is rather owing to the potash they made use of, which was obtained from old, decayed wood, for he made bottles with the same materials, and found they, like the above, spoiled the wine put into them. This potash had lost all its acid salt, which is what renders all glass indissoluble; whereas in these bottles the alkali abounded, the wine dissolved this alkali, which is what turned the wine foul. *These are flat contradictions.*

M. du Fay confirmed this, by employing the same materials and strong potash, made from green wood; these bottles were indissoluble in all mineral acid spirits.

To concentrate vinegar. 1729.

M. Geoffroy proposes here a facile method to have a strong spirit of vinegar, by exposing vinegar to be frozen; as fast as ice is formed, he takes it off; the vinegar by this simple process is reduced to $\frac{1}{3}$, and thereby as much concentrated as it would be after the tedious and usual process by distillation*.

Stahl hinted this method of concentrating vinegar, and if you would separate the oil from this strong spirit of vinegar, distil it;

* Boyle long before taught this method of obtaining a very strong vinegar, by exposing it to be frozen. See *Phil. Trans. abrid. Vol. 3d. p. 355.*

the oil being now lighter than the spirit, will readily come over, and leave the spirit in the cucurbit.

To render creme of tartar soluble by Borax.
1728.

Every body knows how difficult it is to dissolve creme of tartar, nothing less than boiling water is able to keep it dissolved, and as the water grows cold, the creme falls to the bottom, resuming its former crystalline state. To render these crystals soluble in a small quantity of water, and still preserve their native acid taste, was no small improvement in the use of this mild, cooling salt.

M. le Fevre physician at Uzes, and correspondent of the academy writes, that he had discovered a method to render creme or crystals of tartar soluble by Borax. He first observes, that $\frac{1}{2}$ ounce of creme of tartar will require 12 ounces of boiling water to dissolve it; but if the crystals were in fine powder, that quantity of water would dissolve 7 drams, which as the water grew cold, would fall to the bottom, in its former crystalline form: what he proposes is to render it soluble by the means of another salt, which is almost as difficult to be dissolved as the crystals themselves.

M. le

M. le Fevre takes 4 ounces of crystals of tartar in fine powder, 2 ounces of Borax coarsely powdered, and 12 ounces of water; these he puts into a glass cucurbit, placed in a sand heat, and suffers the matter to boil for $\frac{1}{2}$ hour; in this time both these salts dissolve each other without any ebullition, and so thoroughly, they that never after resume their former saline form.

The liquor remains transparent, and acid; if crude tartar had been employed, the solution shou'd be filtered, to separate the gross earthy parts; if this solution of both those salts was evaporated, it would insensibly grow thick, not unlike plumb-tree gum, which left exposed to the air, wou'd deliquesce like salt of tartar.

It is here pretty extraordinary that crystals of tartar, which are indissoluble in cold water, in spirits of wine or vinegar, become soluble in all those liquors by the means of Borax; this tartar rendered soluble by Borax, has the advantage of the tartar soluble of the shops, for this with Borax preserves its natural acidity, whereas the other does not.

M. le Fevre further adds, that it is much better to employ a vegetable acid to make the *sal sedativum* with Borax than the fix'd mineral acid of vitriol, as M. Homberg directed.

Of

Of Borax. 1703.

Borax is a mineral salt, brought from the East-indies, *Persia* and *Transilvania*, in little cristalline masses of an irregular figure, but somewhat prismatical, mixed with earth and other impurities, of a disagreeable smell: it is purified like other salts, and crystallizes into octagonal prisms, finely cut, hard and transparent, of a bitterish taste, but leaving somewhat of a sweetness at going off. It is greatly used to solder metals, particularly gold, whence it is called *chrysocolia*; it is likewise employed in medicine as a great incider and aperitive.

The happy use *M. Homberg* made of it, in the composition of his *sal sedativum*, induced *M. Lemery* the father, to analyse it, in hopes to discover its genuine nature. He found it wou'd not ferment with either an acid or alkali; he therefore concluded it must be a *sal salsum*, neither acid nor alkali. He distilled it in a retort, placed in a reverberatory furnace; 6 pounds yielded 6 oz. 6 drs. of an insipid clear *flegm*, without smell, which wou'd not effervesce with either acids or alkalies; by raising the fire, the remaining 9 oz. 3 drs. melted into a substance like glass, and not unlike crystal, and so hard that a lapidary's sharpest tool cou'd scarce make any impression on it, and yet it dissolves intirely

ly in water, and crySTALLIZES into *borax* again. M. *Lemery* gave some of this solution to a person greatly obstructed, which procured so copious a discharge by urine, that he conjectured it must be good for the gravel.

As distillation cou'd not decompose *borax*, i. e. separate its acid from its alkali, he tried what effect other substances might have on it, he took an ounce and a half of *borax*, and 3 oz. of *argilla*, both well dried, and in powder, which he put into a retort, placed in a reverberatory furnace, which yielded 3 drams of a clear, brackish liquor and urinous smell. Distilled in the same manner with salt of tartar, an insipid, disagreeable, unctuous or oily liquor came over; it is this bituminous substance that occasions the *borax* to swell and blister over the fire, the more it contains of this bitumen, the more it swells.

Lemery the son, made several experiments with *borax*, in 1728, 29, to discover its genuine nature. He there tells us, it is the only salt, whose nature, its analysis, or recombination cou'd not discover; it is not so with all the other concrete salts, with all the kinds of vitriols, alum, sulphur, nitre, sea-salt, their analyses manifest their component parts, as their recombination confirms it. Besides *borax* is the most singular alkali we know, it mixes equally with all the mineral acids,

acids, and with the vegetable acid, and what is very remarkable, it does not excite the least heat or ebullition upon its admixture with acids, contrary to all other alkalies, fixed or volatile, and tho' it is by no means volatile in its own nature, but resists the strongest fire, and wou'd sooner vitrify than rise in sublimation, yet when mixed with the vitriolic acid, the most fixed of all the acids, it becomes not only volatile itself, but surprizingly volatilizes this fixed, vitriolic acid, as we find in making *Homberg's sal sedativum*.

M. *Lemery* by exactly observing *Homberg's* process, obtained a *sal sedativum*, to all outward appearance like his, from *borax* and the nitrous and marine acid, and conjectured from analogy he might obtain the same kind of salt, by employing *borax* and crystals of tartar and vinegar; but his not succeeding with either, he took the spirit of vinegar, as being deprived of its gross oil; and being well known to be much more volatile than any of the mineral acids, he might reasonably expect it would readily sublime with *borax*; but being here also disappointed, he began to reflect, that this must be owing to the bitumen in the *borax*, which so cemented each saline particle together as made them elude the action of the fire; whereas when a mineral acid is employed, this bitumen is first separated from the salt; this salt being dissolved after, and

its surfaces being thereby multiplied, it obeys the more readily the action of the fire, *i. e.* sublimes in the usual way.

From these reasonings we are naturally led to infer, that those acids, which sublime with *borax*, begin by separating the bituminous from the saline parts, and dissolving these parts after, sublime with them, leaving the bituminous parts behind, herein resembling the action of other solvents, highly rectified spirits of wine for example, which is known to dissolve the sulphurous parts only, leaving the saline parts behind, whereas when the vegetable acid is employed, far from separating the bituminous from the saline parts, its acid dissolves the saline, while the spirits or sulphurous parts of the wine, still intimately united with the acid, dissolve the bituminous parts, whereby both solvent and solvend become so united, as to elude the action of the fire ; both therefore remain in the form of a gummy substance in the bottom of the cucurbit.

M. *Lemery* has verified what M. *le Fever* has said of *borax* rendering creme of tartar soluble ; he is of opinion it may have its use in making an emetic tartar soluble, which the tartar soluble of the shops cannot, by reason it has lost its natural acidity, while that with *borax* doth still retain his ; what M. *Lemery* here adds is very curious. This
tartar

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tartar, rendered soluble by *borax*, will dissolve, and remain dissolved in a much less quantity of water, than either salt separately wou'd require ; viz. 4 oz. of creme of tartar require 48 oz. of boiling water to dissolve them, and as the water grows cold, the most part of it falls to the bottom of the vessel in its crystalline form. 2 oz. of *borax* require 24 oz. of the like boiling water to dissolve it, and as the water grows cold, a good deal of it falls to the bottom of the vessel, and yet when both salts are mixed together in the proportions now mentioned, they mutually act upon, and dissolve each other in 12 oz. of boiling water, and what is more, will remain dissolved after the water cools ; nay even in a less quantity, for a good deal of the 12 oz. exhale during the operation ; both salts therefore are, and remain dissolved in less than $\frac{1}{2}$ of what each salt separately wou'd require to dissolve and keep it dissolved.

The reason probably is this. The solution of salts is in a reciprocal *ratio* of their cohesion and surfaces, or in other words, is as the different degrees of attraction between their integral component parts ; the mutual attraction therefore between the integral component parts of the salts in question, may be greater than that between the integral component parts of the new salt, resulting from their union and the water ; perhaps the bitumen, ever inseparable from salts,

might contribute to their closer union; without admitting some such cause, it will be difficult to account, why salts do not remain dissolved in water, their natural solvent; but when this salt is once dissolved in water, and crystallized after, the component parts of this new salt might not so powerfully attract each other, as the component parts of each salt separately wou'd, their attraction therefore being much less, than that of either salt separately, so a much less quantity of water will suffice to dissolve this new salt, and keep it dissolved, and this readily accounts, why a tartar, rendered soluble by *borax*, requires less than $\frac{1}{2}$ part of the water, each salt it is composed of would require separately to dissolve it, owing undoubtedly to the feeble union between its component parts.

This seems to be somewhat illustrated by the following matter of fact. An ounce of the nitrous acid is known to contain 5 drams of water, which are found sufficient to keep the remaining 3 drams of acid salt in a fluid state. 2 ounces of *lixivium tartari* contain one half water, which here likewise is sufficient to keep the other half dissolved; and yet when both these salts are mixed together, in order to compose salt-petre, the above quantity of water is no longer sufficient to keep this new concrete salt dissolved, but it
falls

falls to the bottom of the vessel, until 4 ounces more of water are added.

Tho' this new salt becomes less soluble than the salts it is composed of were separately, yet it helps to shew, that the solution of salt is as the cohesion of their component integral parts.

As to the medicinal uses of *borax*, from what has been said, it must be a great deobstruent in all opilations and glandular infarctions of the liver, spleen, mesentery, womb, and being a powerful absorbent, will effectually absorb all the acidities in the *primæ viæ*, without exciting either heat or flatulencies, as most other absorbents are known to do; by its effects on the crystals of tartar, we are given to understand, that it is a potent incider, able to act upon our fizy juices, which without some such help wou'd like the crystals of tartar, remain indissoluble to water, but when this water becomes impregnated with this tartar rendered soluble by *borax*, it will then be able to penetrate and incide this fizy lymph, open the obstructed tubes, without exciting either heat or confusion in the blood, no small commendation in its favor.

As to the mechanical uses of *borax*, the bitumen which remains fixed in the bottom of the cucurbit after the salt is sublimed, serves, like all other inflammable substances,
to

to promote the fusion of metals, and being more fixed than them, it remains more intimately united with the metals, whereby it contributes greatly to their malleability, when they come under the Hammer. We have a sensible instance of this in the reducing the *calx* of gold into pure and malleable gold again by *Borax*; the mixture is speedily put into fusion, the bitumen in the *Borax*, not only supplies the necessary *phlogiston*, but being also fixed, acts the part of a cement, to unite the several particles of the metal together, while its alkaline salt absorbs those acids lodged in its pores, and volatilizing them after, flies off with them in vapors, or remains with the *scorie* on the top of the metal.

Further experiments with Borax. 1732.

M. *Geoffroy* has likewise made several experiments with *Borax*; he confesses that of all salts, its composition, whether natural or artificial, is but little known; natural history, ancient and modern, affords but little information concerning this *strange salt*; the best account hitherto published concerning it, is what his brother in his lectures on the *materia medica*, gave from the memoirs of a German traveller, and a good naturalist, by name *Naeglin*, who made several researches into the nature of this salt, both in the
Indies

Indies and at *Venice*, where it was formerly purified; “*Borax*, he tells us, is produced in several parts of the *East Indies*, but most plentifully in the dominions of the *Great Mogul* and in *Persia*; that in several places of these two countries there flowed gently from different mines, but principally from those of copper, a saline, muddy water, of a greenish color, which the natives carefully preserve; for this purpose they make shallow pits near those sources, lining them with a stiff clay, that will not let any of the liquor thro’; they after let in this saline water, where it is left exposed to the action of the sun and wind to be evaporated; they every day take care to scoop up the bluish mud of those sources, and carefully mix it with the evaporating water, which the more it evaporates is found capable of retaining more of this mud, till at length the whole becomes of a greenish blue color, and of the consistence of pap. The bituminous matter floating on the liquor is skimmed off, before it arrives at this consistence; they now bring a large quantity of any animal fat melted, and in the full heat of the day, when the whole mass is full warm, they throw it in, observing to work and mix the whole thoroughly well together, they then cover their pits with the boughs of trees, lightly crusted over with some of the same stiff-clay, which they keep
ready

ready at hand for that purpose. They leave the matter in this condition 5 or 6 days, at the end of which, they examine whether the matter is dry about the edges of their pits, and if it be, they remove the covering; in the bottom of these pits is found a fine garden mould, which is easily broken, this earth runs readily thro' sieves, leaving the salt behind in irregular, foul crystals, such as they are imported, this is called native *Borax*.

Homburg looked upon *Borax* to be a mineral urinous salt, *Lemery* the father, considered it as a neutral salt, that wou'd not ferment with either acid or alkali, *Lemery* the son, defined it an alkaline salt, by its precipitating the *basis* of the several kinds of vitriols and alum, nearly as salt of tartar wou'd, which every one knows is an alkali. Besides these marks of its alkaline nature, *M. Geoffroy* adds, that a solution of *Borax* will turn the tincture of violets green, decompose sal-ammoniac, and precipitate a solution of mercury in the nitrous acid into a citron-color, and that of corrosive sublimate into orange-color, equally as salt of tartar wou'd.

Borax its true will yield a *sal-sedativum* with any of the mineral acids, but in order to succeed, it is necessary that the *basis* of the mineral salt employed be totally separated.

This

This M. *Geoffroy* discovered in the very process; for having dissolved 4 ounces of *Borax* and 2 of green vitriol, and setting the matter to sublime, as in the usual way, he found no salt wou'd rise; he dissolved the matter in the cucurbit in warm water, filtered it after, and set it a second time to sublime, but no salt wou'd yet rise; he dissolved and filtered the matter a second time, which having now deposited its ferruginous *basis*, the salt sublimed very readily after. This put M. *Geoffroy* upon discovering the exact proportion of *Borax*, necessary to precipitate the *basis* of each mineral salt; he found that the green required 3 of *Borax* to 1 of it, the blue and white 3 to 2, and alum equal parts of *Borax* to precipitate its *basis*; he also discovered, that it was much better to employ a wide neck'd retort than a cucurbit, and that it was needless to dissolve the *Borax*, all that was necessary was to reduce the saline mass into a paste, the acid by this means penetrates the matter so much the sooner.

Of all the vitriols, the blue affords more, the green next, and alum after, but the white the least quantity of this volatile subacid salt. The salt obtained from *Borax* and all mineral salts, is in thin, shining white plates, and perfectly of the neutral kind; for a solution of it makes no change in the color of a tincture of violets, nor in a so-

lution of corrosive sublimate, or mercury in the nitrous acid. Thrown into cold water, it remains on its surface, so light is it; but it dissolves intirely in warm water, and crystallizes into the same thin, shining plates it was; the only observable difference is their being thicker and heavier. This salt recrystallizing in this manner, first suggested to M. *Geoffroy*, that full as good might be made by crystallization as by the tedious process of sublimation, which he accordingly did, and at the same time as perfect a *Glauber's salt* as is made in the usual way. The process is this, he dissolves 4 ounces of refined *Borax* in a sufficient quantity of warm water, he gradually pours ten drams of highly concentrated oil of vitriol into the solution, and sets it after over a gentle fire to evaporate; as soon as he perceives small, fine, shining pellicles on the surface of the evaporating liquor, he lets the fire out, these fine crystals becoming every instant, both too large and heavy to remain suspended, fall to the bottom of the pan in beautiful crystals; if the pan happens to be stirred, till those crystals are formed, their natural, crystalline arrangement is interrupted. The remaining liquor is pour'd off by inclination, and the crystals are washed 2 or 3 times with cold water, to deprive them of any saline matter that might adhere to them, they are
left

left to drain a while, and set after to dry in the stove or sun.

This salt made by crystallization is light like snow, soft to the touch, smooth on the tongue, lightly bitter, leaving a slight impression of acidity on the palate, differing from that by sublimation in its weight only, owing to the water it took in its crystallization, whereas what is made by sublimation has none. By all the trials made with both, they do not seem to differ, for, 1°. exposed to the most intense heat of the sun, it does not calcine, which wou'd not be the case, did it contain either *Borax* or *Glauber's salt*, which are known to calcine, when thus exposed; whenever it does calcine, its owing to neglect, in not washing the adhering saline matter, but here it is but dissolving and crystallizing it anew. The superabundant salt will remain in the water, while the *sedative salt* falls to the bottom of the pan, and to have it quite free from any adhering salt, let it be washed 3 or 4 times with cold water before it is put up for use. 2°. Neither of them makes any change in the color of a tincture of violets, or in a solution of mercury in the nitrous acid. 3°. Both dissolve equally in spirit of wine, and upon burning it, exhibit the same green flame. 4°. When both salts are set to sublime, the only observable difference is, that

by sublimation seemed to rise more readily, and required but 6 sublimations, and left but 6 *grs.* of a *caput mort.* whereas that by crystallization required 8 sublimations, before it wou'd part with all its volatile salt, and left after 12 *grs.* of a *caput mort.* Lastly, both salts put on an ignited iron, they lost above half their weight, and what remained of both salts vitrified equally.

There is this advantage in making this salt by crystallization, that there is as much made at once, with abundantly less trouble, as by several tedious sublimations, and that without running any risk of breaking the vessels, which very often happens, whereby one's labor is lost; this might have its use in *hospitals*, where there is so great a consumption of it.

As the oil of vitriol with *Borax* and kelp makes equally as perfect a *Glauber's salt* as with decrepitated sea salt, it is obvious the *basis* of *Borax*, kelp and sea salt are the same; it further appears from these experiments, that *Borax* contains two distinct salts, separable by any of the mineral acids, the one volatile, which sublimes, the other fixed, which forms a new concrete salt, a *Glauber's salt* with the vitriolic, a quadrangular nitre with the nitrous, a true marine salt with the marine acid. This volatile salt contains beside a vitrescible earth. For this salt is
found

found to vitrify, at least in part, but may be re-crystallized into the same salt it was, equally as *borax* in the same state is*.

Of Lixivial Salts. 1728.

Most chemists are herein agreed, that all lixivial salts are concrete or neutral salts decomposed in part, *i. e.* deprived of the greatest part of their acid by the action of fire. As a proof of this, those lixivial salts are regenerated by adding an acid of the same

* Notwithstanding the many experiments hitherto made with *borax* by those learned chemists, *Homburg*, *Lemery* father and son, *Geoffroy* and others, it must be confessed they have not been able to discover the genuine nature and composition of this *strange salt*. *M. Baron* has since their time let us more into its true nature than any of them, and by what he has already discovered, we have reason to expect he will leave nothing relative to its composition unobserved; he has made a *sedative salt*, with the vegetable acid, which no other chemist before him cou'd, he has likewise demonstrated, that this *sedative salt* actually pre-existed in the *borax*, united with an alkali, the same as the *basis* of sea-salt, consequently that it is not owing to a combination of the acid employed and the alkali in the *borax*, as *Homburg* and all other chemists hitherto believed; the only use therefore of an acid in making this salt is to disengage this alkali, the *sedative salt*, now freed from its alkali, is obtained by sublimation or crystallization, in fine, thin crystals. This *M. Baron* has incontestably proved, by regenerating *borax* on his adding the *basis* of sea salt to this *sedative salt*, a proof the most compleat that can be had, and which in matters of this kind, amounts to a demonstration, see *Baron* apud *Macquer*. It is I must own pretty odd, how that learned chemist, *Geoffroy* cou'd overlook this, for as the remaining liquor, after this *sedative salt* was removed, yielded upon evaporation a *Glauber's salt*, he might well suspect that all his vitriolic acid did, was to disengage the alkali, leaving the *sedative salt* to crystallize by itself.

nature

nature of that they lost; an instance of this we see in the fixing of nitre, which by the action of fire is deprived, like all other fixed alkaline salts, of the greatest part of its acid, and thereby acquires all the properties of a fixed alkaline salt, it ferments with all acids, deliquiates in the air, &c. now, to establish this salt in its former state, restore to it as much of the acid of nitre as the fire deprived it of, and you will have the same concrete salt regenerated, a true nitre.

It is here sufficiently obvious, that all the change the nitre suffered in the above process, was the loss of its acid, and as evidently shews that all lixivial salts are in like manner, rendered fixed alkaline salts by being deprived of their acids; for these like nitre, may be established in their former concrete state, by restoring to them the same kind of acid the fire deprived them of.

What can be more plain, or more obvious to our very senses than this manner of accounting for the production of all lixivial salts? for the more simple any *hypothesis* is, the more it seems to have the character of truth impressed on it; however, the great *Stahl* hath proposed another, diametrically opposite to it; in his *hypothesis*, salts become alkaline by the addition of something they had not before. All agree as to the agent,
fire,

fire, but differ in their manner of explaining how salts become lixivial, as much as the operations of addition and subtraction in arithmetic differ.

Stahl in his *Fundamenta Chimie*, positively affirms, that all salts, had by incineration from plants, become alkaline, by their combination with the sulphurous parts of the plants as they are burning; as a proof of this, he recommends "to take any plant well dried in a shade, cut small after, and to pour on it spirits of wine while they extract any oil from it, or till the spirits come off as clear as when poured on; burn this plant after, yet it will not yield one atom of an alkaline salt."

M. *Stahl* concludes from this experiment, that it is the sulphur or oil in the plant, combined during the incineration with the essential salt, that converts this into an alkaline salt; for we are to take notice, that in this *Hypothesis*, there is no decomposition of the salt; both the acid and alkali still remain, and are only altered from their former state, by their combination with the oil of the plant, during the incineration; for adds he, "if it was not this oil that wrought that change, that converted the concrete salt of this plant into an alkaline salt, how came the above plant not to yield an alkaline salt after its incineration? all it lost was

was its oil ; wherefore as this plant yielded no alkaline salt, after it was deprived of its oil, it is evident that it is the combination of this oil with the essential salt of the plant, in the time of incineration, that produces all the alkaline salts, had from plants after incineration.

This experiment at first view seems conclusive, the more so as it is a matter of fact, that no plant, after it is deprived of its essential oil, will ever yield an alkaline salt by incineration.

M. *Bourdelin* admits the fact, but at the same time contends, this oil becomes no otherwise necessary for the production of alkaline salts, than as it is the means the fire makes use of, to decompose the essential salt in the plant ; this oil by its promptitude to take fire, assists the fire to decompose the essential salt, *i. e.* to disengage the acid from its alkaline, fixed *basis*, and as it exhales, it carries off with it the acid, leaving the earth and fixed salt in the ashes ;

Stahl's plant therefore being deprived of its oil, the fire was not able to decompose the essential salt, *i. e.* separate its acid from its alkali, so this essential salt remains in the ashes undecomposed, and may by elixiviation, &c. be had in its own genuine form ; it is therefore the oil, that by means of the fire

fire decomposes, disunites the essential salt of the plant, that separates its acid from its alkaline *matrix*, and exhaling with it after, leaves the fixed alkaline salt behind in the ashes.

We have a pregnant proof of this in the process of fixing nitre; let nitre be kept ever so long in fusion, it will never become fixed, or an alkaline salt, it would sooner exhale in vapors, but upon adding any *phlogiston* to it, the powder of charcoal for example, it is soon decomposed; the fire in this process makes use of the oil in the charcoal to disunite the nitrous acid from its alkaline *matrix*, which acid the oil as it burns, carries off with it, leaving the fixed alkaline salt in the crucible; the very same thing happens upon the incineration of the plant, the oil as the plant is burning, disunites the acid from its fixed *basis*, and flies off with it in vapors, leaving the fixed salt in the ashes.

That the part the essential oil in the plant has, in the production of all alkaline salts, is to assist the fire to disunite the essential salt, to separate the acid from its fixed *matrix*, and after to fly off with it, we have an incontestible proof in a curious experiment of M. Lemery the son's; he put an equal quantity of *colcothar* into 2 separate crucibles, he added some oil to the one;

upon increasing the fire about both crucibles equally, the one with the oil in it was soon decomposed, and deprived of its acid as manifestly appeared by its adhering to the *magnet*; whereas the matter in the other crucible required a fire of fusion, before it cou'd expel the acid it contained, so as to manifest its ferruginous nature.

Seeing therefore the oil, added in the above process to a substance, exposed to the action of the fire, had power to detach its acid, tho' it had no manner of connection with it, and afterwards to fly off with it, might we not reasonably expect, that the oil in the plant shou'd have a much greater power to detach the acid it is combined with, and carry it off after in those vapors, that exhale in the incineration of all plants?

But further, the manner how all alkaline salts are regenerated, must overthrow this *hypothesis*; this is effected by adding to the alkaline salt an acid of the same nature of that the fire had deprived it off; now, in *Stahl's* system, the essential salt of the plant is not decomposed, suffers no other alteration, but its being joined with the oil of the plant, and yet he will have it an alkaline salt.

How the pouring of an acid, suppose the nitrous acid on *lixivium nitri*, according to this notion of *Stahl*, cou'd regenerate *nitre*, must

must ever remain unintelligible; his nitre suffered no other change than receiving a portion of oil from the charcoal, which it had not before; the nitre remains intire, and yet it is become alkaline: how will nitre that remains intire, ever receive the acid of nitre to regenerate it? To regenerate a salt that was never decomposed, implies a manifest contradiction; but all this is very easily understood in the other system; the alkali of nitre is a porous substance, being deprived of the most part of its acid by the action of the fire, but still is capable of becoming the same salt, upon adding the acid it lost.

And as to this oil, *Stahl* pretends is combined with the essential salt, were there any of this oil, mixed with the alkali of nitre for example, it wou'd be found floating on the surface of the solution, when the nitrous acid had taken its place, upon the regeneration of nitre; but no such oil is ever seen, and here it cannot with any color of reason be offered, that this oil exhaled during the operation, an oil that had resisted the action of fire, in the fixing of nitre, is not likely to exhale in the manner here pretended.

Again, that something more happens to nitre, in the process of fixing it than its combination with the oil in the charcoal, is evident by the considerable diminution in

its weight, and it is as evident, that this diminution in the weight of nitre is owing to the *evolution* of its acid, which the *phlogiston* in the charcoal had detached and carried off with it.

Chemists have always considered all alkaline salts to be the same, let them be had from ever so different substances, accordingly in all their different processes they indifferently substitute one for the other, without ever perceiving any sensible difference; and to consider the manner, how lixivial salts are made, it does not appear that there shou'd be any material difference between them; for the fire acts alike on all bodies exposed to its action, and were we to consult our eyes only, or palate, we never shou'd be able to discover any difference in the ashes of different plants, and yet it is consistent with both reason and experience, that there should be some difference between the alkaline salts, had from different plants; for some plants are known to contain a vitriol, others nitre, others again a sea salt; as the *basis* of these salts is different, so it is evident that those plants after their incineration, must yield an alkaline salt of quite a different nature; for if you pour the vitriolic acid on the alkali of the sea salt for example, the produce will be a *Glauber's salt*, and not a sea salt regenerated; as is manifest

manifest by the figure of the crystals, those of *Glauber's salt* being quadrilateral. While those of sea salt are cubes; again, if the nitrous acid is poured upon the same *basis*, no sea salt is produced, but a nitre of a quadrangular figure; it is therefore sufficiently obvious, that such plants as are known to contain different concrete salts, must yield different fixed alkaline salts, after their incineration.

A chemical examen of the several kinds of flesh-meats, commonly employed to make broths.
1730.

M. *Geoffroy* the younger's view in making those *analyses* was, by knowing the quantity of extract each kind of flesh-meat yielded, to determine the quantity of nourishment each broth did contain, that the physician might be the better able to regulate the diet of the sick. And tho' M. *Geoffroy* is entirely of M. *Lemery's* opinion, that of all aliments, what is procured from vegetables must be the fittest for sick persons, as containing less volatile principles, of course more analogous to *Nature* at this time, yet as custom has ordered it otherwise, and broths are esteemed the most wholesome, as well as the most necessary, in all kinds of disorders, he judged a proper examen of the principles, contained in this animal food, wou'd enable the
physician

phifician to order it with more prudence, by which means he may, on the one hand, avoid the danger of allowing it too freely, where the cafe required a ftrict diet, and on which perhaps the recovery of the patient chiefly depended; and on the other hand, not to be too fparing of it, when the patient, exhausted by long ficknefs, required a fuller diet; according to this plan, he analysed all thofe different kinds of animal food, generally made ufe of; his method is this: He takes a certain quantity by weight of each, boils it after in 3 feveral waters, he evaporates thofe broths to the confiftence of an extract; he takes fome of this extract, and analyses it, to difcover how much volatile falt and oil it contained; he likewise dries the remaining flefhy fibres in a ftove, and analyses them after, from a hint given by M. *Dodart*, after the late M. *Bourdelin*, that the flefh of animals boiled to a gelly, and diftilled after, yielded no lefs a quantity of volatile falt than if they had been diftilled raw; the *lixivum* from the *caput mort.* gave evident figns of its containing a fea falt, by its precipitating a folution of *mercury* in the nitrous acid, but made no change in a folution of the fublimated corrosive, a proof this *lixivium* contains no alkaline falt.

M.

M. Geoffroy further observes, that as veal abounds more in gummosse parts than beef, and yields besides more extract, and of a more solid consistence than beef, veal-broths might probably be more fit nourishment for children, to lengthen and enlarge their vessels than beef-broths; those gummosse parts in veal-juices, destined for the nutrition and growth of the animal, may be supposed to bring the same disposition with them, to lengthen the bones, cartilages, tendons, vessels of the animal, who takes them for his food, and give all his parts the same firmness they wou'd the animal they were had from; upon the same principles those same veal-broths must be very proper, to repair decayed constitutions, and fill up such bodies, as thro' sickness or other wastes, have been greatly emaciated.

Mutton by those analyses is found to contain more nourishing, volatile parts than either beef or veal, and leaves less fixed matter after its *analysis*.

But chicken is found to yield more extract than either beef, veal or mutton; for a chicken weighing 9 oz. 4 drs. yields 7 drs. 36 grs. of extract.

Now, as these are the flesh-meats commonly employed to make broths, let us see, how much 3 pints of broth, supposed to the quantity allowed a sick person in 24 hours, affords;

affords; those broths are generally made of a pound of the lean of beef, a pound and a half of a fillet of veal, and half a capon, which may weigh 14 ounces, the whole weighing 3 pounds 6 ounces, boiled in 7 pints of water over a slow fire, till reduced to 3 pints, which when the meat is sufficiently boiled, is in a gelly; this divided after into 6 messes, one to be taken every 6 hours, will contain 2 ounces, 5 drams, 34 grains of extract, which being compared with the whole weight of meat and bread, a man in health may be supposed to eat, in the same time, appears to be more than enough to support him: how mistaken are the vulgar, in imagining a sick person is not sufficiently nourished by both!

But as there are many cases where veal, or chicken water only is allowed to the sick, it may also be proper to see, whether even this veal water (as it is called) might not afford sufficient nourishment to a sick person; to make this veal-water, a pound of a fillet of veal is boiled in 4 pints of water, reduced to the half; this is found to contain 1 oz. 1 dr. 48 grs. of extract. Chicken water is made by boiling a chicken, which may weigh $9\frac{1}{2}$ oz. in the like quantity of water; this likewise is found to contain 7 drs. 36 grs. of extract; add to this, that the volatile parts of those light broths are by boiling

boiling extracted, of course pass more readily into the blood to recruit it, whereas those contained in the flesh itself, require too great an action of the stomach to digest and extract them; besides, those light broths readily mix with the ptisan, and other decoctions, the sick person might have occasion to take, to cool and temperate his blood.

And as we are informed, that the people of *Ireland* scarce take any other nourishment in their several maladies, but *two milk-whey*, that is, whey made with sour butter-milk, instead of runnet; it may not be improper to examine whether this also might not afford sufficient nourishment to a sick person: 8 lb. of clear runnet whey, evaporated in MB. almost to dryness, (whey is not to be thoroughly dried, the instant it is taken off the fire, it becomes moist), yielded 9 oz. 24 grs. of extract, which is 1 oz. 1 dr. 3 grs. to every pound of whey.

As fish are sometimes used in making broths, M. *Geoffroy* has also analysed some of them, to try how far the old prejudice, of fish being less nourishing than flesh, was true: a pound of carp, clear of skin and bones, yielded 1 oz. 8 grs. of extract, whereas a pound of beef yielded but 7 drs. 8 grs. of extract, but this contains 38 grs. more of volatile salt than that of carp.

Lastly, as bread is the staff of life in all countries, on which $\frac{2}{3}$ of the people live intirely, this is found to contain abundantly more nutritious parts than any flesh-meat whatsoever; for a pound of sound bread yielded 5 oz. 1 dr. of extract, which probably is what by digestion is separated from it, for the nourishment of the body.

M. Geoffroy pursuing the same inquiries in 1732, analysed the solid parts of animals, their bones; he took the shavings of the leg of an ox, of harts-horns, ivory, viper-bones; the result of all these *analyses* is clearly set forth in the annexed tables.

A table of the extracts made from several kinds of flesh-meats.

	oz.	dr.	gr.
1 lb of beef, boiled in 3 several waters yielded in			
Extract,	0	7	8
The fibres dried in a stove weighed	3	2	0
1 lb Veal, boiled in the same manner	1	1	48
The dried fibres weighed	2	7	32
1 lb Mutton, boiled in the same manner	1	3	16
The dried flesh weighed	2	7	24
1 lb of Lamb yielded in soft extract, not easily to be dried	1	1	39
A Chick, flesh and bones, wt. 9 oz. 4 dr. 48. gr.	0	7	36
The dried flesh and bones weighed	1	6	40
An old cock, wt. 1 lb. 2 oz. 6 dr. in solid	4	7	66
A capon, clear of fat, wt. 1 lb. 7 oz. 1 dr. 48 gr. in soft	1	5	0
Two house pigeons, wt. 14 oz. in solid	0	7	35
A pheasant, flesh and bones, wt. 2 lb. in soft	2	4	16
Two old partridges, wt. 1 lb. 2 oz. 5 dr. in a fat oily	1	6	30
A turkey, clear of fat, wt. 9 lb in an oily	12	0	43
Two calfs hearts, wt. 11 oz. 4 dr. not to be dried	0	3	60
A calf's			

from the ROYAL ACADEMY. 331

	oz.	dr.	gr.
A calf's liver, wt. 2 lb. 7 dr. of a watery Extract, 2	2	1	60
Eight calfs feet, wt. 6 lb. 8 oz. in a gummy dry	8	3	27
The bones, cartilages, after boiling weighed 2 lb	10	0	0
Two macreuses, wt. 2 lb. 7 oz. in solid	2	1	50
1 lb of the shavings of an ox's leg, in a dry	3	3	36
1 lb of the shavings of harts-horns	4	2	63
1 lb of the shavings of ivory	4	7	1
1 lb of carp, clear of skin and bones, in solid	1	0	8
4 oz. of pike, boiled as the carp, in solid	0	2	24
2 lb of frogs flesh, thighs and legs only	1	1	36
A small land-tortoise, clear of shell, wt. 8 oz.	0	5	6
4 oz. of cray-fish, washed and pounded	0	2	33
2 oz. of vipers flesh, clear of fat, skin, in a gelatinous	0	1	36
8 lb of runnet whey, in soft	9	0	24
1 lb of sound bread, made without barm, milk, or salt	5	1	0

A table of the analyses of the foregoing extracts and dried fibres.

1 dr. 56 gr. of the extract of beef yielded in vol. salt	0	1	2
Oil and spirit	0	0	38
Caput mortuum	0	0	6
Loss	0	0	10

Total 0 1 56

6 dr. 36 gr. of the dried fibres, in vol. salt	0	2	0
Vol. spirit	0	0	36
Caput mortuum	0	1	60*
Loss	0	2	12

Total 0 6 36

2 dr. 30 gr. of veal extract, in vol. salt and oil	0	1	12
Caput mortuum	0	1	0
Loss	0	0	18

Total 0 2 30

* We are always to remember that the French dram contains 72 gr.

	oz.	dr.	gr.
5 dr. 62 gr. of the dried fibres, in vol. falt	0	1	66
Oil and spirit	0	1	37
Caput mortuum	0	2	18
Loss	0	0	13
Total	0	5	62

2 dr. 58 gr. of mutton extract, in vol. falt	0	1	0
Oil and spirit	0	1	0
Caput mortuum	0	0	54
Loss	0	0	4
Total	0	2	58

5 dr. 60 gr. of the dried flesh, in vol. falt and inseparable oil	0	3	12
Spirit	0	0	24
Caput mortuum	0	2	0
Loss	0	0	24
Total	0	5	60

7 dr. 36 gr. of chicken extract, in spirit, oil and flegm	0	4	15
Volatile falt and oil	0	0	58
Caput mortuum	0	2	20
Loss	0	0	15
Total	0	7	36

6 dr. 18 gr. of the dried flesh, in spirit and thick oil	0	3	34
Volatile falt	0	1	0
Caput mortuum	0	1	6
Loss	0	0	50
Total	0	6	18

3 dr. 9 gr. of the bones, in spirit, oil, vol. falt	0	0	69
Caput mortuum	0	2	8
Loss	0	0	4
Total	0	3	9

from the ROYAL ACADEMY.

333

	oz.	dr.	gr.
1 dr. 56 gr. of the extract of a Pheasant, in spirit and oil	0	0	48
Volatile salt	0	0	36
Caput mortuum	0	0	36
Loss	0	0	8
Total	0	1	56
6 dr. 36 gr. of the dried fibres, in spirit, vol. salt, thick oil	0	5	10
Caput mortuum	0	1	12
Loss	0	0	14
Total	0	6	36
1 oz. of calf's-feet extract, in spirit and oil	0	3	0
Volatile salt	0	2	18
Caput mortuum	0	2	25
Loss	0	0	29
	1	0	0
1 oz. 45 gr. of extract, from the shavings of an ox's leg, in a white volatile salt in ramifications	0	3	18
Caput mortuum	0	2	36
Its <i>lixivium</i> gave a faint appearance of its containing sea-salt			
1 oz. 45 gr. of extract from the shavings of harts-horns, yielded in volatile salt in ramifications	0	2	0
Citron colored spirit and fetid oil	0	0	30
Caput mortuum	0	2	36
4 oz. of the remaining mass after boiling, analysed in the same manuer, in volatile salt	0	1	18
A <i>lixivium</i> of the <i>cap. mort.</i> weighing 3 dr. 24 gr. gave manifest signs of its containing sea-salt			
4 oz. 7 dr. 1 gr. of an extract from ivory, in vol. salt	0	0	48
Spirit and thick black oil	0	3	36
The white remaining paste afforded no volatile salt, but a citron colored oil, and a volatile spirit of a bluish color, making in the whole	0	4	36
A <i>lixivium</i> of its <i>capt. mortuum</i> precipitated a solution of corrosive sublimate, but had no effect on a solution of mercury			
1 dr. 56 gr. of the extract of carp, in vol. salt	0	$\frac{1}{2}$	0
Spirit and a brownish oil	0	$\frac{1}{2}$	0
			Caput

	oz.	dr.	gr.
5 dr. 62 gr. of the dried fibres, in vol. salt	0	1	66
Oil and spirit	0	1	37
Caput mortuum	0	2	18
Loss	0	0	13
Total	0	5	62
2 dr. 58 gr. of mutton extract, in vol. salt	0	1	0
Oil and spirit	0	1	0
Caput mortuum	0	0	54
Loss	0	0	4
Total	0	2	58
5 dr. 60 gr. of the dried flesh, in vol. salt and inseparable oil	0	3	12
Spirit	0	0	24
Caput mortuum	0	2	0
Loss	0	0	24
Total	0	5	60
7 dr. 36 gr. of chicken extract, in spirit, oil and flegm	0	4	15
Volatile salt and oil	0	0	58
Caput mortuum	0	2	20
Loss	0	0	15
Total	0	7	36
6 dr. 18 gr. of the dried flesh, in spirit and thick oil	0	3	34
Volatile salt	0	1	0
Caput mortuum	0	1	6
Loss	0	0	50
Total	0	6	18
3 dr. 9 gr. of the bones, in spirit, oil, vol. salt	0	0	69
Caput mortuum	0	2	8
Loss	0	0	4
Total	0	3	9

	oz.	dr.	gr.
1 dr. 56 gr. of the extract of a Pheasant, in spirit and oil	0	0	48
Volatile salt	0	0	36
Caput mortuum	0	0	36
Loss	0	0	8
Total	0	1	56
6 dr. 36 gr. of the dried fibres, in spirit, vol. salt, thick oil	0	5	10
Caput mortuum	0	1	12
Loss	0	0	14
Total	0	6	36
1 oz. of calf's-feet extract, in spirit and oil	0	3	0
Volatile salt	0	2	18
Caput mortuum	0	2	25
Loss	0	0	29
	1	0	0
1 oz. 45 gr. of extract, from the shavings of an ox's leg, in a white volatile salt in ramifications	0	3	18
Caput mortuum	0	2	36
Its <i>lixivium</i> gave a faint appearance of its containing sea-salt			
1 oz. 45 gr. of extract from the shavings of harts-horns, yielded in volatile salt in ramifications	0	2	0
Citron colored spirit and fetid oil	0	0	30
Caput mortuum	0	2	36
4 oz. of the remaining mass after boiling, analysed in the same manuer, in volatile salt	0	1	18
A <i>lixivium</i> of the <i>cap. mort.</i> weighing 3 dr. 24 gr. gave manifest signs of its containing sea-salt			
4 oz. 7 dr. 1 gr. of an extract from ivory, in vol. salt	0	0	48
Spirit and thick black oil	0	3	36
The white remaining paste afforded no volatile salt, but a citron colored oil, and a volatile spirit of a bluish color, making in the whole	0	4	36
A <i>lixivium</i> of its <i>cap. mortuum</i> precipitated a solution of corrosive sublimate, but had no effect on a solution of mercury			
1 dr. 56 gr. of the extract of carp, in vol. salt	0	$\frac{1}{2}$	0
Spirit and a brownish oil	0	$\frac{1}{2}$	0
			Caput

<i>Caput mortuum</i> weighed	oz. dr. gr.
Loss	0 0 48
A <i>lixivium</i> of its cap. mort. gave the usual signs of its containing sea salt by precipitating a solution of mercury	0 0 8
6 $\frac{1}{2}$ dr. of the dried flesh, in vol. salt in ramifications	0 1 36
Spirit and oil	0 2 60
<i>Caput mortuum</i>	0 1 6
Its <i>lixivium</i> produced a white precipitation in a solution of corrosive sublimate, but did not affect a solution of mercury	
2 dr. 24 gr. of the extract of pike, in spirit and oil	0 0 46
Vol. salt of an urinous smell	0 0 30
<i>Caput mortuum</i>	0 1 11
Its <i>lixivium</i> produced a white precipitation in a solution of mercury; but made no alteration in that of corrosive sublimate	
4 dr. 59 gr. of the dried fibres, in spirit and oil	0 2 56
Volatile urinous salt	0 0 16
A <i>lixivium</i> from its cap. mort. which weighed 1 dr. 50 gr. produced first a white, then a yellowish precipitation in a solution of mercury, and a white in corrosive sublimate.	
1 dr. 56 gr. of extract from frog's flesh, in vol. salt	0 0 56
Vol. spirit and oil, somewhat thick	0 0 48
<i>Caput mortuum</i>	0 0 36
Its <i>lixivium</i> produced a white precipitation of corrosive sublimate, but did not affect a solution of mercury.	
6 dr. 36 gr. of their dried fibres, in vol. salt in ramifications	0 2 0
Spirit and oil of a deep yellow color	0 $\frac{1}{2}$ 0
<i>Caput mortuum</i>	0 2 0
Its <i>lixivium</i> produced only a white precipitation of corrosive sublimate, but did not disturb a solution of mercury.	
5 dr. 6 gr. of extract from a land-tortoise, yielded in Volatile spirit and rich oil	0 0 54
<i>Caput mortuum</i>	0 2 24
Its <i>lixivium</i> would not precipitate a solution of corrosive sublimate, but did that of mercury.	
6 dr. 48 gr. of the dried fibres, in spirit and oil	0 2 0
Vol.	

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	oz.	dr.	dr.
Vol. salt in ramifications	o	o	66
<i>Caput mortuum</i>	o	3	46
Its <i>lixivium</i> produced the same precipitation with the former			
2 dr. 33 gr. of cray-fish extract, in spirit, oil	o	1	20
The vol. salt cou'd not be collected, it was so little.			
<i>Caput mortuum</i>	o	1	o
Its <i>lixivium</i> produced at first, a white precipitation in a solution of mercury, but after it became of a grayish black color, but did not disturb that of corrosive sublimate.			
6 dr. 39 gr. of their fibres, in spirit and oil	o	2	4
Vol. salt in ramifications	o	o	20
<i>Caput mortuum</i>	o	1	o
Its <i>lixivium</i> produced a yellowish white precipitation in a solution of mercury, but made no alteration in that of corrosive sublimate			
1 dr. 36 gr. of extract of vipers, in spirit, oil, vol. salt	o	o	54
<i>Caput mortuum</i>	o	o	54
Its <i>lixivium</i> gave all the signs of its containing sea salt			
3 dr. 66 gr. of the dried fibres and bones yielded in spirit, oil and vol. ammoniacal salt *	o	1	54
The caput mortuum weighed 2 dr. 6 gr. Its <i>lixivium</i> produced a white precipitation in a solution of mercury			
9 oz. 24 gr. of extract of whey in an acid citron colored spirit and pretty thick oil	4	6	36
The <i>Caput mortuum</i> weighed 3 dr. 6 gr. which exposed to the air, deliquiated, and yielded after cubic Cryssals.			
It is here pretty remarkable that the first animal juice, such is milk, shou'd contain sea-salt.			
6 dr. of the extract of bread, an acid orange colored spirit and fetid oil	o	3	o
The <i>lixivium</i> of the <i>caput mort.</i> which weighed 2 dr. produced a slight precipitation			

* 2 oz. of the dried bones having produced 82 gr. of vol. salt in a dry form, amply justifies the ancients in ordering the boiling of vipers to draw out their principles in the *Trechisi pro Theriaca*. Besides, the bones rendered friable by boiling, furnish a substance like prepared hartshorn, and by their analysis contain near as much volatile salt as hartshorn.

in

in a solution of mercury, which indicates its containing a pittance of an ammoniacal or urinous salt. The dried paste treated in the same manner yield the same principles.

These *analyses* furnish us with some curious observations. 1°. It appears that the more solid parts of animals, their bones, upon boiling in water yield their principles and volatile salts both sooner, and in a greater quantity than their flesh: For 6 *drs.* 36 *grs.* of dry fibres, that remained of 4 *oz.* of flesh, yielded 3 *drs.* of volatile salt and oil, whereas 4 *oz.* of the dried mass left after the bones, yielded 3 $\frac{1}{2}$ *drs.* of spirit with a very little fetid oil, and so little volatile salt, that it cou'd not be weighed. 2°. That tho' the flesh had deposited, as one might reasonably expect, all its principles in the water, yet the remaining dried fibres yielded a considerable quantity of volatile salt. 3°. Harts-horns by their *analysis* approach nearer to flesh than to bones, for at first they are but a fleshy substance; as may be seen in the small sprouting horns of the deer; besides, harts horns yield an urinous salt, which bones scarce ever do. 4°. Ivory resembles bones pretty much, and like them consists of *lamine*, for if sawed into thin circles, boiled after in water, these *lamine* are easily separated; besides, ivory by its *analysis* yields the same principles, and a greater quantity of extract than bones, but less volatile salt,
owing

owing probably to the long traject from those excessive hot countries, by which its volatile salts are dissipated before it comes to us. 5°. It is likewise evident, that the younger the animal is, his bones approach the nearer to the nature of flesh. 3 drs. 9 grs. of the dried bones of a chicken yielded 35 grs. of an urinous or ammoniacal salt, whereas the extract from the broth required the strongest fire to raise its volatile salt, not in ramifications, but in flat crystals, for the most part like parallelopipedons, whereas what is obtained from the dried fibres is in beautiful ramifications, and under a drier form. Lastly the *lixivium* made from the *caput mortuum* of most of those *analyses* gave manifest signs of its containing salt, by precipitating a solution of *mercury* in the nitrous acid, and very often in fair cubic crystals.

Of the composition of the Sal-rupellense. 1731.

M. Seignette, an apothecary at Rochelle, happened to discover a method of rendering the crystals of tartar soluble, to which he gave the name of sal-polychrest, which soon acquired so great a reputation as to be the only salt in *fashion*; for medicines are known to have their *modes*, and often thro' whim to be laid aside and forgot, if some lucky chance or caprice does not bring them into *fashion* again. The famous Carthusian powder,

among many other good medicines, has experienced this whim of *fashion*; but *Seignette's* salt is an exception to this caprice of the public, the more it was used, the greater reputation it acquired, so as at present to be employed in most parts of *Europe*, an evident proof of the real merit of the medicine.

This universal great esteem for this salt excited several chemists to discover its composition, but to little purpose; the author had the pleasure during his life, to find it remained a profound secret, and as such transmitted it to his heirs. *M. Boulduc* among the rest piqued himself to discover its composition; he accordingly put some of it, first on a live coal, the vapor it exhaled, readily betrayed its containing tartar, or creme of tartar; the coal it left made the same impression on the tongue as all our fixed lixivial salts do; from hence he conjectured that this famous salt must be a kind of a tartar soluble; but to be convinced of this, he put 2 ounces of this salt into a retort, from which he had a clear limpid liquor, with a black oil floating on the top of it, both which manifested their being the spirit and empyreumatic oil of tartar: *M. Boulduc* distilled in the same manner 2 ounces of tartar, which yielded him exactly the same kind of spirit and oil.

Tho'

Tho' M. *Boulduc* by this single experiment was certain that this salt was no more than a tartar soluble, yet as it differed in many things from the tartar soluble of the shops, made with the crystals and salt of tartar, the difficulty was to discover, what alkali the author employed, to render those crystals soluble; and here M. *Boulduc* confesses, he probably wou'd remain in the dark, as well as those, who had before him attempted the same thing, were it not for a hint he got from M. *Gross*, a great chemist and an acquaintance of his, who had been long employed in making experiments with *Kelp*; M. *Boulduc* no sooner tried this salt with his crystals than he presently discovered, that the alkali *Seignette* employed, was that of kelp, of which he had good plenty at *Rochelle*, where he lived. *Seignette* might without any design, employ this alkali, to render the crystals of tartar soluble, as most chemists are of opinion that all fixed alkalis are the same; so one may be indifferently substituted for the other.

At the time M. *Boulduc* had been employed in discovering the composition of *Seignette's* salt, M. *Geoffroy* the younger was likewise employed in search of the same thing, and without their ever communicating their designs to each other, happened

about the same time to discover its composition.

To make *Seignette's* sal-polychrest, get the best *Alicant* kelp you can, make with it a strong *lixivium*, filter it after; pour on this *lixivium* the crystals of tartar in powder to perfect saturation, filter the solution, to separate a kind of grayish, light earth that precipitates during the conflict, evaporate the solution according to the usual way, you will find fine transparent crystals, exactly like those of *Seignette's* salt.

It is difficult to give the just proportion of the *lixivium* to the crystals, some kelp being better calcined than others; but the surest method is to give it to full saturation.

M. *Boulduc* found that a *lixivium* of 6 lb. of *Kali* wou'd generally dissolve 2 lb. 4 oz. of crystals of tartar, and when the *Kali* is richly impregnated with salt, a like *lixivium* of 6 lb. will dissolve an equal weight of the crystals or creme of tartar, so great difference is there to be found in this alkaline salt, owing no doubt to its being more or less calcined, of course more or less impregnated with salt.

If there cou'd remain any doubt of the conformity of this salt with that of *Seignette's*, the following experiment must necessarily remove it: dissolve equal quantities of both salts separately in warm water, pour into each solution the oil of vitriol to
full

full saturation; when the operation is over, a saline concretion is found in the bottom of the vessel, which is found to be a true *creme of tartar* regenerated. In this operation, the oil of vitriol attracts the alkali in the salt, and with it forms a *Glauber's salt*, in the same manner as if the same oil had been poured on the *lixivium* of *Kelp*; the *Sal polichrest de Seignette* therefore is no more than a *creme of tartar* rendered soluble, by the alkaline salt of *Kelp*.

By the composition of this salt we might learn its virtues, as it is a neutral salt, easily soluble in any liquid, it must be attenuating, aperient, resolvent and penetrating; given to the quantity of an ounce, it is gently purgative, and often given with mineral waters to assist their operation, in which case it seems to be much preferable to the *Sal Catharticum amarum*, or any other neutral salt in all intentions, where such salts are used.

To render Tartar soluble. 1732 and 1733.

Tartar, or what is pretty much the same, crystals of tartar, a salt so much in use, being indissoluble in our juices (nothing less than boiling water can keep it dissolved), has induced chemists to render it soluble, but till very lately they did not apprehend it cou'd be rendered soluble so well by any
alkali,

alkali, as by its own, so the tartar soluble of the shops, made with those crystals and salt of tartar was all that was known, till 1728, M. *le Fevre* first proposed a method of rendering it soluble with *borax**.

M. *Boulau* in his inquiries into the composition of *Seignette's* salt, has discovered, that it was no more than a tartar, rendered soluble by the alkali of *Kelp*; here then are three different alkalies, capable of rendering tartar soluble, and probably there are many more such alkalies capable of rendering it soluble.

Messrs. *du Hamel* and *Grosse* happened to be employed pretty much in the same manner as Messrs. *Boulau* and *Geoffroy* were in the pursuit of the same thing, *i. e.* without the knowledge of each other. M. *du Hamel* wanted to purify tartar as they do at *Montpelier*. M. *Grosse* wanted to discover all such earths or salts as were capable of rendering tartar soluble; but when it was known that both were employed in the same pursuit, they ever after acted in concert. After they had mixed several things with tartar, they at last discovered this *touch-stone*, which soon after led them to what they wanted, to render tartar soluble.

They considered tartar as the essential salt of wine; they also considered that the acid of tartar, and that of vinegar was the

* See before page 301.

same,

same, it necessarily followed that such earths or salts as are soluble in vinegar, will be so with tartar, or in other words, will render tartar soluble, and this they found to be true in fact: those gentlemen further discovered that such earths as were indissoluble in vinegar, wou'd still purify tartar, undoubtedly by absorbing its coarser oil.

By the above *test*, the earth about *Roan*, which sugar-boilers use, the earth they use at *Montpellier* to purify tartar, the earth of *Tripoli*, *Gypsum* or plaster of *Paris*, *Crayons*, *bol*, *terra Sigillata*, *Creta Britannica*, fullers earth, wou'd not dissolve in vinegar, while lime, chalk, oyfter shells, calcined and not calcined (with this difference, that it dissolved more of the calcined), dissolved readily in vinegar; accordingly all those rendered tartar soluble as well as pot-ashes, *crabs* eyes, and every other earth soluble in vinegar.

It is observable that several of those earths which rendered tartar soluble, do not decompose the tartar, or separate its acid from its fixed alkaline *base*, but by insinuating themselves between the integral component parts of the crystals, they render those crystals more accessible to the water; those earths therefore are not intimately united with this tartar soluble; for by pouring any mineral acid upon a solution of this tartar soluble,

soluble, the acid instantly attracts this alkaline earth; the crystals of tartar now separated from this earth, precipitate to the bottom of the vessel in their genuine crystalline form; even the vegetable acid will produce the same effect.

This sufficiently evinces that those crystals in the tartar soluble were no way decomposed, they only absorbed so much of this earth as was necessary to render them soluble, which they as readily parted with to the first acid presented to them.

From those experiments it is evident that not only alkaline salts, such as salt of tartar, kelp, *Borax*, but also alkaline earths of the mineral kingdom, such as lime, chalk, &c. alkaline substances of the animal kingdom, as oyster shells, calcined, and not calcined, burnt harts horns, &c. and vegetable alkaline earths, such as the *Cineres Clavellati*, first deprived of all their fixed salts by several lotions in warm water, will render crystals of tartar soluble. By the same experiments it appears those tartar solubles may be regenerated by pouring the vitriolic, nitrous, or marine acid on any of their solutions; these being much stronger than the vegetable acid in the tartar soluble, seize the alkali, that rendered the crystals soluble, whereupon those crystals fall to the bottom of the vessel, which if not speedily separated from the acids,

acids, these will decompose the crystals, and with them form quite another salt, as either this or the other mineral acid had been employed; and what is still more extraordinary, even the acid of vinegar will regenerate those crystals in the tartar soluble, excepting that made with *Borax*, as appears by the following experiments.

Messieurs *Grosse* and *du Hamel* made solutions of tartar, rendered soluble by *Borax*, *Kelp*, salt of tartar, calcined oyster-shell-powder, chalk, and *Cineres loti*. Those different solutions they put into separate glasses, and at different times poured the acid of vinegar into each of them, upon which a fermentation more or less sensible ensued, as also a precipitation more or less sudden, in every one of the glasses, except that with *Borax*. This precipitate was a regenerated creme of tartar; the remaining liquor was very acid, which induced them to evaporate it, to see what sort of salt it contained; they found some irregular extremely acid crystals, soluble in water, a true tartar soluble, become more acid than it naturally is, owing to the acid of vinegar that was here added to it.

But to account how this acid, which is the same with that in the tartar soluble, cou'd here precipitate the crystals of tartar, we must consider that the acid in the tartar soluble, has besides its own alkaline *basis*, an

additional one, the alkaline salt that rendered it soluble; so when the acid of vinegar is poured upon a solution of this tartar soluble, it seizes the adventitious alkaline salt only; by this means this crystals of tartar, being deprived by the acid of vinegar of the alkaline salt that rendered them soluble, they presently return to their natural crystalline form, *i. e.* become true crystals of tartar.

This is somewhat illustrated by what we know happens, upon pouring the same acid of vinegar on a solution of *hepar sulphuris*. This acid seizes the alkali joined to the sulphur; the sulphur is precipitated in much the same manner, the crystals of tartar were precipitated in the above experiments.

As all the tartar solubles do not, with the same facility, quit this adventitious alkaline salt, upon the pouring of the acid of vinegar on their solution, so we shall here range them, according to the order in which they are precipitated, and become regenerated crystals of tartar.

1°. Tartar soluble made with *Cineres loti*, precipitates the readiest of all.

2°. That made with chalk.

3°. That made with uncalcined oyster-shell-powder.

4°. That made with lime.

5°. That

5°. That made with calcined oyſter-shell-powder.

6°. That made with ſalt of tartar.

7°. That made by kelp.

8°. And laſtly, that made with *Borax* will not precipitate upon, pouring the acid of vinegar on its ſolution.

This viſible difference between theſe ſeveral tartar ſolubles is owing to the leſſer or greater attraction between the ſeveral alkaline ſubſtances employed, and the acid in the creme of tartar, or to what may amount to the ſame thing, to the different alkalicity of the ſeveral ſubſtances employed to render tartar ſoluble.

What is further obſervable in all thoſe tartar-ſolubles is, that tartar rendered ſoluble with *cineres loti*, chalk and lime, will diſſolve with very little moiſture; that made with calcined oyſter-shell-powder and ſalt of tartar will diſſolve with the moiſture of the air; but that made with *Kelp* and *Borax* wou'd ſooner calcine than liquify, when expoſed to the air.

Probably the reaſon is this: Such tartar-ſolubles as deliquiate in the air, might have too great a proportion of an alkaline ſalt to the acid they contain; this ſuperabundant alkaline ſalt attracts the moiſture of the air, and by that means the ſalt is diſſolved. Something like this is obſerved in *Glauber's*

salt and vitriolated tartar, when their acid predominates; they like the above tartar-solubles, deliquiate in the air.

To extract Mercury out of Lead, 1733.

Those conversant in *Metallurgy* know, that lead ore has often joined with it several other metals, as zinc, antimony, silver, gold, and copper; and some are of opinion it often has mercury joined with it. M. *Gross's* view in all the experiments he made with lead was to discover, whether it had not mercury joined with it; he therefore took 8 ounces of the nitrous acid and as much water, to weaken it, he put into it 4 ounces of the glaziers thin grooved plates; to forward the solution, he placed the *matrass* in a sand heat; he observed that in proportion as the lead was dissolved, a greyish powder precipitated, which when rubbed on gold, or copper, turned them white, and that some globules of mercury appeared mixed with it.

M. *Boerhave* the year following 1734, positively asserts, that in all the tryals he had made with either pewter or lead, he never cou'd extract mercury from them, how confidently so ever authors have asserted the contrary.

These are flat contradictions. Time only, and further experiments can determine on which side the truth is.

Of

Of emetic tartar, and kermes mineral. 1734.

These preparations of antimony, being powerful medicines, wou'd be of more general use, were they equally prepared by the Chemist, but as that is not the case, as each artist has his peculiar manner of compounding and preparing those medicines, it therefore greatly behoveth the prescriber to know exactly the quantity of *reguline* parts, contained in a given dose of each of those preparations. For it is well known that the emetic tartar of one shop will be full strong at 3 grains, while that of other shops will require 6 or 7 grains to have the same effect.

It is exactly the same with regard to the *kermes mineral*, that of some shops will scarce excite a *nausea* given to 3 or 4 grains, while that of another shop shall vomit at a grain, or a grain and a half, without any visible reason for those different effects.

Now, antimony itself, in powder, is neither remetic nor purgative; it consists of the vitriolic acid, a *bitumen* or mineral oil and a metallic, vitrescible earth, as its *analysis* clearly evinces. It is this vitrescible earth that is emetic in antimony, but while this mineral is in its natural state, this metallic earth is so enveloped, and as it were crusted over with the *bitumen*, that its action on the stomach is prevented; but when this *bitumen* is

is in the whole, or in part separated from this metallic earth, it becomes then more or less emetic, as we see in both the *Kermes* and the *vitrum antimonii*, the last, by being totally deprived of its *bitumen*, is powerfully emetic; the *kermes*, by still retaining some of this *bitumen*, is only less so.

As therefore it is of some importance to the public, to know exactly the strength of those powerful medicines, so M. Geoffroy has here endeavored to discover this matter. He got a certain quantity of those medicines, as made in 12 different shops in *Paris*. The method he took to discover how much reguline parts, each given quantity of those medicines contained, or rather shou'd contain, to be safely taken, was by *resuscitation*. He took an ounce of each, and with as much more of the black fluxing powder (two parts of red tartar and one of nitre calcined together), put it into different crucibles, placed in a *fusory fire*. When the matter appeared in *fusion*, like oil in the bottom of the crucible, he let the fire out. Upon breaking the crucibles, he finds his *regulus resuscitated*.

By this method he discovered that the weakest emetic tartar yielded from 30 grains to a dram 18 *grs* of reguline parts to an ounce; that an emetic tartar of a middle strength yielded 1 $\frac{1}{2}$ dram, and the strongest
of

of all, 2 *drs* 10 *grs* of reguline parts to an ounce of emetic tartar.

By this experiment an emetic tartar, which contains but 32 grains of reguline parts to an ounce, will contain but 4 grains to a dram, of course but $\frac{1}{18}$ of a grain of reguline parts to a grain of the emetic tartar; this emetic tartar will therefore be too weak.

An emetic tartar that contains 2 *drs* of reguline parts to an ounce, will contain 18 grains to a dram, which is $\frac{1}{4}$ of a grain of reguline parts to a grain of the emetic tartar; this is as much too strong as the former was too weak; therefore it wou'd be too violent even at one grain, but that emetic tartar which contains 1 $\frac{1}{2}$ dram of reguline parts to an ounce, will contain 13 $\frac{1}{2}$ grains to a dram, which is $\frac{3}{16}$ of a grain of reguline parts to a grain of the emetic tartar; this will work sufficiently and safely at 2 or 3 $\frac{1}{2}$ grains; this dose contains $\frac{1}{7}$ of a grain of reguline parts.

There is the same difference in the preparation of the *kermes mineral*, as in that of emetic tartar, consequently one *kermes* may contain more reguline parts than another, which must ever render its effects uncertain (it will vomit some, purge others, and sweat a third); but to have a *kermes* to act only as a powerful deobstruent, and not to excite
even

even a *nausea*, purify the common *kermes* of the shops *. For this purpose, put a dram of this *kermes* into a large *matrass* with $4 \frac{1}{2}$ lb. of water, and $2 \frac{1}{2}$ drams of fixed nitre, which to have in a dry form, shou'd be well purified by dissolution, filtration and exsiccation, boil them after, the coarser reguline parts will precipitate, pour off the liquor, and when it is cold, you will have a fine *kermes*, of a brilliant red color, and by much, more certain in its effects than the first; for this *kermes* never becomes emetic, except thro' some accident, as by injudiciously mixing it with vegetable acids; its true there is a loss of one half of the *kermes* employed; a very insignificant consideration, when a medicine of so great importance is rendered thereby more effectual and certain in its operations.

Tho' by the above process *kermes mineral* might, and is rendered a safe and powerful deobstruent, yet as it is seldom to be found prepared in that manner, M. *Geoffroy* assures us we may, in all confidence, employ antimony in substance, prepared after his manner, which he affirms will be found possessed of all the virtues of the *kermes*, and exempt from its inconveniencies; he prepares it thus: He takes a pound of the
best

* See before, p. 269.

best *Hungarian* antimony, has it powdered and sifted thro' a fine lawn sieve, and porphorized after on the flag with a little water only, till it is reduced to an impalpable powder, as he judges by putting some of it under his teeth; he puts this powder into a bowl of water, stirring it with a wooden *spatula*; and when it had stood for 15 seconds, the water is then poured off by inclination on one or more filters; the powder left on the filter is dried after in a stove, and ground again with sugar-candy well dried, in the proportion of one dram to every ounce of the prepared antimony; they shou'd be ground together as long as any brilliant particles are discernable upon exposing it to sun; if none appear, it is then prepared.

This simple preparation of antimony has been long famed for all disorders of the lungs, a potent deobstruent in the asthma and other disorders.

Kunckel being greatly afflicted with the rheumatism, consulted *Senertus* the younger in 1674, by whose advice he took this powder for a month, and was cured. The same *Kunckel* was sorely afflicted with the gout in 1679, he had recourse to the same prepared antimony, had it made up into *lozenges* with sugar of roses, and was cured; these are to this day known in many towns

in Germany, by the name of *Kunckel's lozenges*.

M. Geoffroy from his own experience assures us, that it is a sovereign medicine in the *rickets*, and all glandular infarctions; it is as efficacious in expelling worms, and has been found serviceable in the *fluor albus*, after the *universalia* had preceded. It is, however, prudent to begin with a small dose, a grain or two, and increase it gradually to 8 or 10 grs a day; tho' this preparation of antimony is no way emetic, yet it may not be improper to grind up with each dose 3 or 4 grains of some of the *testacea*, as crabs-eyes, and at the same time to forbid the use of sharp acid wines, or acid vegetable herbs in their soups, such as sorrel, &c.

It follows from what we have here said that this *kermes* is no more than a *hepar sulphuris*, wherein the reguline-parts are highly attenuated, and for that reason the *kermes* is less emetic than emetic-tartar; 2°. That by purifying *kermes* as before directed, it might be deprived of its emetic quality, and rendered deobstruent only; lastly, that we may to very good purpose, substitute in its place antimony prepared as before directed.

M. Geoffroy making further experiments with *kermes* in 1735, has 1°. Shewed that antimony may, by reiterated ebullitions, be

be totally converted into a *kermes*, all to a few coarse, earthy parts; 2°. That *kermes* might be made by fusion equally as good as what is made by ebullition. Lastly, that a magistery of antimony, made with *aqua regia*, may in many cases, especially in hospitals, and for the poor, be substituted in the place of either, or its other more operose preparations.

M. Geoffroy had the patience to repeat those ebullitions 78 times, with the same alkaline liquor, adding each time filtered rain-water only, to supply the place of what had exhaled, and taking care to remove the slimy residue, left after each ebullition on the filter, viz. he took the 5 lb. of antimony and *lixivium nitri*, which had been used before for six ebullitions, and now weighed 2 lb 13 oz. and without any other addition, but filtered rain water, he made 30 ebullitions, which yielded 7 oz. of as fine *Kermes* as the first six ebullitions did; and here observing, that the liquor acted as strongly on the reguline parts as at first, he made 20 ebullitions more, which produced him 5 oz. 1 $\frac{1}{2}$ drams of *Kermes*, and by 10 ebullitions more he obtained 4 oz. 1 $\frac{1}{2}$ dram of the same *Kermes*, so that the second 30 ebullitions afforded 2 oz. 5 drs more of *Kermes* than the first 30, owing probably to the coarser sulphurous parts being, by re-

iterated ebullitions abraded, the reguline parts became more exposed to the action of the *menstruum*.

The slimy residue that after each ebullition remained on the filter, and which he each time carefully put by, now weighed 3 oz. those he boiled 12 times in the same alkaline liquor; he had 2 oz. 3 $\frac{1}{2}$ drams of as good *Kermes* as any he had before, so that the 5 lb of antimony by 78 ebullitions yielded 1 lb 4 oz. 3 drs. 24 grs. of *Kermes*, and probably by continuing the ebullitions, the whole of the antimony employed, may be converted into *Kermes*.

We must not think that all this *Kermes* is made up of reguline parts, it is rather a composition of the alkaline salt employed, together with the sulphur and reguline parts of the antimony. M. Geoffroy has been able to ascertain those different proportions by the following experiment.

He took 24 grs of the purest filings of steel, had them ground after on the flag, and mixed with them a dram of *Kermes*. He fluxed this mixture, as in the usual way of making a *regulus* of antimony; during this operation there sublimed, round the edges of the crucible, fine, white flowers. The operation over, he separated the *scoria* from the *regulus*, which he found weighed 10 $\frac{1}{2}$ grs, together with the former 4 grs of reguline

reguline flowers, and 2 grs he judged might still remain with the *scoria*. To separate the other parts in these *scoria*, he put them into the nitrous acid, which soon dissolved the ferruginous parts, leaving the sulphur untouched. He poured this solution by inclination into another vessel, and with the powder of galls, precipitated those ferruginous parts, leaving the salt and sulphur by themselves; whereby he computes that a dram of *Kermes* may contain about 17 grains of reguline parts, 14 of saline, and 41 grains of common sulphur.

By the many experiments M. Geoffroy made with *Kermes*, he hit upon a facile method of making it by fusion, as fine and well colored as what he had made by ebullition. He made trial with several fixed salts, and in different proportions, before he cou'd exactly hit upon that, which wou'd yield the most *Kermes*. In the course of those experiments he observed, that the purer his fixed salt was, *i. e.* the freer from any other salt mixed with it, the sooner the matter wou'd flux, and the more *Kermes* he had; the process that succeeded best with him was, two parts of antimony and one of a fixed salt; for when he employed equal parts of both, he found 18 or 19 grs of regulus, and if he had employed 3 to 2, *i. e.* an ounce and a half of the alkali to one of the antimony,

his

his *regulus* wou'd weigh 49 grs besides what may be lost; so by repeated tryals he found the best proportion to be two of antimony to one of the fixed alkaline salt.

He therefore takes 1 oz. of antimony in an impalpable powder and $\frac{1}{2}$ oz. of fixed nitre, well purified and in a dry form; the antimony being reduced into an impalpable powder, mixes the better with the salt, and fluxes the sooner. He puts this mixture into a retort, placed in a reverberatory furnace, to prevent his losing any of it. A *flegm* came over first, some red vapors after, which denote the nitrous acid. Upon taking off the dome of the reverberatory, he perceived the matter in the retort had acquired a red color, and upon gradually encreasing the fire, it became intensely red, this being the test of the matter's being perfectly fluxed. He now takes out this matter, and while yet hot, has it powdered in an iron mortar, and put into a *Paris* pint of boiling rain water, and keeps it boiling for two hours; when about one half or more of the water is evaporated, he filters it boiling hot, observing to have two *Paris* pints of boiling water in the pan under the filter, to keep the alkaline salts in the mixture extended, that they may be the better able to dissolve the reguline parts. As the filtered liquor grows cold, it here, as in the process by ebullition, lets fall

fall a fine, red powder, a *kermes*. The coarse powder left on the filter is boiled for two hours more with the same liquor, filtered after, and what is left on the filter is boiled a 3d time, with the same liquor, the *kermes* left after those several ebullitions is carefully dried in a shade, and kept in bottles for use.

Salt of tartar, as being freest from any mixture with any other salt, wou'd succeed even better than fixed nitre, which in spite of the greatest attention in fixing it, still retains some nitre undecomposed. Potash being nearly the same with salt of tartar, wou'd equally answer, but being combined with a more or less portion of vitriolated tartar, it requires to be purified, by dissolution in cold water, filtration and exsiccation. Kelp likewise, being known to contain marine salt, requires to be purified after the same manner. Salt of wormwood purified, will have the same effect, *i. e.* produces a *kermes* by fusion.

M. *Geoffroy* has found, that an ounce of antimony, treated after his manner, will yield from 5 to 6 *drs* of as fine a *kermes* as is had by the process, published by the king's authority*.

Tho' M. *Geoffroy* has experienced, that no other process but what is here mentioned will

* See as before page, 269.

will afford a *kermes*, yet he is of opinion a lesser portion of a fix'd salt may be sufficient to open the antimony, so as it may impart its virtues to those sudorific ptisans, which without some such preparation, it wou'd never impart any thing to water. The late famous *empiric* in *Paris*, whose ptisan maintained its credit during his lifetime, used to flux his antimony with salt of worm-wood, in the proportion of 3 *drs* of the salt to an oz of the antimony, as was discovered after his death. *How egregious therefore has our ignorance hitherto been in recommending to boil crude antimony in making our sudorific ptisans!*

M. Geoffroy still pursuing his inquiries, and willing to discover the exact proportion of the common sulphur and reguline parts in antimony, after many trials, he found, that 2 drams of sulphur to 8 *drs* of *regulus* was the exact proportion of both. This is evinced by the following process. He put 2 drams of sulphur with 8 *drs* of *regulus* of antimony into a retort, (to prevent any loss in the operation, as was before observed) placed in a reverberatory furnace; the operation finished, he found in the bottom of the retort a beautiful cake of antimony resuscitated; it is here evident had he not employed the exact proportion of sulphur some of his *regulus* wou'd remain
unresuscitated,

unresuscitated, and if too much sulphur had been employed, some of it wou'd be found sublimated at the neck of the retort; but intirely to decide the matter, M. Geoffroy made as good *kermes* with this resuscitated antimony as with the best *Hungarian* imported.

These Experiments, whereby M. Geoffroy acquired the knowledge of the exact proportion, between the sulphur and the reguline parts in antimony, enabled him to obtain a greater quantity of *regulus* from antimony than any chemist before him cou'd. *Lemery* the father could never obtain more than 6 oz 1 dr. from 1 lb of antimony. *Stahl* cou'd obtain but $7\frac{1}{2}$ oz, and at most but 8 oz per lb. But M. Geoffroy had 10 oz per lb. Chemists have employed different kinds of substances to obtain this *regulus*, such as oils, animal fat, nitre, tartar, charcoal-powder, &c. But what succeeded best with him was black soap, made with a strong ley of potash, and lime, and oil, as linseed, rape, hemp-oil or animal fat. His process is this. He calcines his antimony, to deprive it of as much of its coarser sulphur as he can, the antimony is now reduced to a *calx*. He takes 2 oz of this *calx* reduced into powder, and near as much of this black soap, which he makes into balls, those balls he puts one after another into a red hot crucible, placed in a naked fire, he then covers the crucible, and raises a fire of

fusion about it; when he finds the matter is in perfect *fusion*, he lets the fire out; upon breaking the crucible the *regulus* in the bottom weighs 1 oz 5 drs but as it is not sufficiently pure, he powders it a new, mixes it with half its weight of the same *calx*, fluxes both together, he then covers the crucible, and separates after the *scoriae*. 1 oz 5 drs of impure *regulus* by this process yields 1 oz 3 drs 62 * grs of pure *regulus*.

Vitrum antimonii treated in the same manner, yields a *regulus*; but when diaphoretic antimony is treated in the same manner, a crust is soon form'd over the matter, and upon removing the crucible into a corner of the laboratory, where it lay for 5 hours, and breaking this crust after, a detonation ensued, the matter in the crucible was instantly dispersed all round. This was owing to the nitrous acid in the deaphoretic antimony, which readily quitting the reguline parts to join the fixed alkali in the soap, forms with it a *phosphorus*, which by the sole action of the air, takes fire, as all phosphoruses are known to do. The *calces* of other bodies are known readily to take fire; M. Geoffroy saw a sad instance of this, a piece of ice staved a boat full of quick lime; as soon as the water got to the lime, it set the boat a fire, and this set several other boats

* We before observed that the French dram contains 72 grs.

boats on fire, which happened to be close to each other on the river *Seine*.

M. *Geoffroy* unwilling to leave any thing unobserved, relative to those useful antimonial preparations, has here added his manner of obtaining a magistery of antimony, by the means of an acid solvent. He can't help expressing his surprize, how this magistery came to be so totally neglected, especially as M. *Lemery* the father, in his elaborate treatise of antimony, had so early as 1706, from many trials with it, found it so beneficial, particularly in hospitals and among the poor, as it comes cheap, is easily made, and may be well substituted in the place of its other preparations. For when it is properly made it is found to purge or vomit at the dose of 3 or 4 *grs*, equally as the *kermes* in the same dose, and at one grain, it becomes diaphoretic. The children of the poor, were in a peculiar manner often relieved from their worm and other fevers, by giving them one grain at a time, and as it hath neither smell nor taste, they readily take it. However, for the greater security, it may be ground up with sugar-candy, or crabs-eyes to moderate its action. M. *Geoffroy* made trials with all the mineral acids separately; oil of vitriol, whether concentrated or diluted, or the marine acid wou'd but corrode it, the nitrous wou'd dissolve some, and *aqua regia*, as it is

usually made, wou'd dissolve more than either, but wou'd very soon after abandon it, insomuch that upon adding *lixivium tartari*, no more wou'd precipitate: When therefore chemists tell us *aqua regia* will dissolve antimony and its *regulus*, they should give the composition of their *aqua regia*, and the proportion between the solvent and solvend. By the many trials M. Geoffroy made, he found that *aqua regia*, capable of dissolving antimony or its *regulus*, must be composed of four parts of the nitrous and one of the marine acid, no other proportion wou'd completely dissolve it. That made with the nitrous acid and sal ammoniac wou'd soon abandon what it had dissolved; he besides found that there must be 16 parts of the solvent to one of the solvend, *i. e.* a dram of *regulus*, or a little more of antimony, wou'd require 16 drams of *aqua regia*, and even in this proportion, it is necessary to break the antimony or its *regulus* into small parcels, and not to put in a second, till the first is dissolved. This magistery upon the affusion of clear water precipitates, isedulcorated after by several ablutions with boiling water, till it becomes insipid, and is after dried and kept for use.

Of the basis of sea salt. 1736.

The discovery of the *basis* of sea salt has been long one of the *desiderata chemica*. Chemists have long known that the *basis* of sea salt was an alkali *sui generis*, as they termed it; they have been able to transfer this *basis* to another acid, as in making a *Glauber's salt* with oil of vitriol, and decrepited sea salt; but a chemist never thinks he thoroughly knows a substance, till he can decompose it, and after examining each part separately, to know it perfectly, he recomposes the same, by uniting its component parts: it is by this means that nitre, alum, vitriol, &c. are said to be salts well known; because the chemist after he has decomposed them, he can compose them a new, which is called the regenerating of salts; but no chemist hitherto has been able to decompose sea salt, so as to have separate its *basis* and acid, and be able by uniting them after, to recompose or regenerate it. It is true, he has by an *intermedium*, separated its acid, and transferr'd its *basis* either to the vitriolic or nitrous acid, but cou'd never have this *basis* separate, free from an acid.

M. du Hamel had the good fortune to discover this *basis*. From *analogy* it appeared to be the same as that of the kelp, *borax*, the *natrum* of the antients; for by pouring
the

the vitriolic acid on a solution of any of those alkaline salts, a *Glauber's salt* is produced; with the nitrous acid, a quadrangular nitre, and with the marine acid, a true marine salt in cubic crystals, directly as if the *basis* of sea salt and its own acid had been employed, whence one may naturally infer, that the *basis* or alkali of the above salts, and that of sea salt is the same; but this was not sufficient, it must be produc'd by itself; M. du Hamel employed several methods for this purpose.

It is an *axiom* in chemistry that the most violent action of fire is not able to expel a mineral acid, when it is once intimately united to a fixed alkaline salt, V. 6. No action of fire can decompose nitre, vitriolated tartar, *Glauber's* and marine salt, they will not part with the least atom of their acid, without the assistance of some additament; it is also known that the vitriolic acid, employed as an additament, will expel any other acid from its *basis*, and take the place of the acid so expelled, but no acid can expel the vitriolic acid from its *basis*. This acid however is known to unite readily with the *phlogiston*. M. du Hamel made use of this *medium* to separate the vitriolic acid from the *basis* of sea salt. He first banished the marine acid from its *basis*, by the help of the vitriolic acid, as in
making

making a *Glauber's salt*. And by the assistance of the *phlogiston*, he detached this acid from this same *basis*; for this purpose he fluxed his *Glauber's salt* with the powder of charcoal; by this process he had a *hepar sulphuris*, the vitriolic acid quits here the *basis* of sea salt, to join the *phlogiston* in the charcoal, and forms with it a sulphur; the alkali, the *basis* of the sea salt, now abandoned by its acid, is ready to unite with the first acid that presents; thus by pouring the acid of vinegar upon a solution of *hepar sulphuris* in water, the sulphur precipitates to the bottom of the vessel, the acid of vinegar, being here naked, seizes the alkali, the *basis* of sea salt, before joined to the sulphur. All that now remained was to expel this acid of vinegar, to have the *basis* of sea salt separate, in its own genuine saline form. He put this solution into a glass retort, and after the acid of vinegar and its oil, ever inseparable from it, came over, he cut the retort in two with a wet string (the retort being exposed to the violence of a naked fire, was now ready to melt) and what was in the retort, he had powdered while it was yet hot; and totally to deprive it of all vegetable oil it might still retain, he calcined it in a crucible, placed in a naked fire, by which chain of processes, he obtained this alkali or *basis* of sea-salt; this salt turned a
tincture

tincture of violets green, proof of its being an alkali; it precipitated a solution of corrosive sublimate, and dissolved intirely, and with effervescence in the acid of vinegar; it crySTALLIZES nearly like *Glauber's salt*, and blisters on an ignited iron, it dissolves intirely in water, but will not deliquiate in the air, it becomes rather a kind of *farina*, it is bitter on the tongue, leaving the impression of a lixivial salt behind; when he poured the oil of vitriol on it, he had a *sal Glauberi*, and not a vitriolated tartar, as he wou'd have, was this salt a vegetable alkali, with the same salt and the nitrous acid a salt-petre, which was not in *striæ*, as it is known to be, when the nitrous acid is poured on a solution of sea salt; lastly when he poured the marine acid on this salt, he had a genuine sea salt regenerated, in fair cubic crystals, all which do evidently prove, that this is the genuine *basis*, or alkali of sea salt.

M. *du Hamel* obtained the same alkali by another process; he first banished the marine acid, by the help of the nitrous acid; the salt here produced is a quadrangular nitre; he fluxed this nitre with the powder of charcoal, in order to separate the nitrous acid from this *basis* or alkali of sea salt; when the detonation is over, and the matter is in a perfect *fluor*, he dissolves it in distilled rain

rain water, filters, evaporates, &c. and so obtains the *basis* or alkali of sea salt, united before to the nitrous acid in the above quadrangular crystals.

M. du Hamel compared this salt with the *natrum* of Egypt, having first deprived it of the marine salt it never is without; by every trial he made, they seemed to be the same; he further conjectures that kelp is the *basis* of sea salt, deprived of all, or the greatest part of its acid, and is the same that is obtained from plants and animal substances after their incineration.

Becher must undoubtedly have employed the vitriolic and nitrous acids to discover the *basis* of sea salt; but he expresses himself so enigmatically, that it is hardly possible to guess what he would be at; all he says is, *Nativum alkali nusquam datur, nisi in sale communi, nempe materia illa, quæ huic Corpus præbet.* Messrs. Lemery and Bourdelin in du Hamel's latin history of the Royal Academy, were well apprized of the same thing. *Demonstratur si Sal Commune miscetur cum bono spiritu vitrioli aut nitri, utrinque prodit spiritus salis; residuum in retorta est sal novum, ex acido vitrioli aut nitri ex hoc corpore fixo conflatum; unde si acidum illud vitrioli aut nitri, ab hoc corpore iterum avellatur, remanet alkalinum salinum corpus:* but none of them have directed how to separate those

acids they had substituted in the place of the marine acid, this was reserved for the researches of M. du Hamel, which after a most tedious chain of processes, he at last accomplished.

To Volatilize the Oil of Vitriol. 1742.

M. Geoffroy's view in this process is to separate the essential oil in the spirit of wine, by the means of the vitriolic acid; he confesses several chemists before him had attempted the same thing, among those are Paracelsus, Vanhelmont, Gesner, Val. Cordus, Fr. Hoffman, Stahl, Pott, Messrs. du Hamel, Gross and Hellot.

M. Pott in his treatise *de acido Vitrioli Vinoso*, which properly is a comment on Hoffman's manner of making his *liquor anodinus mineralis*, directs to take 1 part of oil of vitriol, so concentrated as to burn a straw put into it, and 4 parts of highly rectified spirits of wine, he advises to pour by degrees the oil of vitriol on the spirit of wine, this mixture becomes considerably warm, and exhales some agreeable vapors, which M. Pott pretends are hurtful to the lungs, he leaves this mixture for some days in digestion, he then adapts a receiver, and closely luting the junctures, he distills it in MB. the spirit that comes over is of an agreeable smell and taste, and may be about half of
what

what cou'd rise with such a heat ; this is followed by a 2d of a stronger smell and more sulphurious, the 3d is still more so ; by continuing the same degree of fire, the matter begins to boil, a most suffocating sulphurious *flegm* comes now over, together with a clear oil floating on it ; this oil must be separated as speedily as can be, otherwise the *flegm* would intirely dissolve it ; the operator shou'd here watch to suppress the bath-heat the instant the matter begins to swell, otherwise it wou'd pass over into the receiver, so one's labor is lost.

M. *Geoffroy* by his method obtains more of this essential oil, and employs less of the oil of vitriol than any chemist before him ; to have the oil of vitriol as concentrated as it can be, he distilled 10 lb of the common black oil of vitriol in a retort ; the *flegm* came over first, a weak acid liquor next, but the 3d, 4th, and 5th became more and more acid, so that the 6th was as acid as good oil of vitriol ; what remained in the retort became perfectly limpid, and as concentrated as it cou'd be, it wou'd burn a straw dipped into it. M. *Geoffroy* takes here notice, that this black oil of vitriol will never become so limpid, by employing an open vessel, a cucurbit, as by making use of a retort, which prevents any matter floating in the air mixing with it, and those in

the oil are consumed during the distillation; this concentrated acid weighed 2 lb 1 oz; the weight of common water to it was as 641 to 1171.

Whenever M. Geoffroy prepared *Hoffman's liquor anodinus mineralis*, he put 4 parts of the spirits of wine to one of this concentrated acid, but his view here being to separate the essential oil of the spirit, he put but 2 lb of an old, oily spirit of wine, which he had by him for 8 years, to 1 lb of this concentrated acid, he put the mixture into a retort, placed in a close reverberatory furnace, and by the heat of a lamp that had but one match in it, kept up day and night for a month, he obtained 1 lb 7 $\frac{1}{2}$ oz. of an aromatic, lightly sulphurous spirit, and by continuing the distillation with 2, and after with 3 and 4 matches, till the matter in the retort began to swell, he found, when the vessels were cold, in the receiver 3 oz 2 drs of a very clear oil, of an amber color, and agreeable, aromatic smell, tho' a little sulphurous; the light acid *flegm* that came over with it, weighed 2 oz 7 drs, and the black mass in the retort 1 lb 2 oz 3 drs; so there was no loss, tho' the operation continued so long, owing no doubt to the closeness of the junctures.

M. Geoffroy observing that the matter swelled considerably, and apprehending it
wou'd

wou'd burst his vessels, which were of English crystal, and carefully fitted for nice operations of this kind, determined to repeat the operation after another manner; he therefore, contrary to the method of other chemists, pours the spirit on the mineral acid, which being so much lighter, will always float on it; he for this purpose got a glass-tundish made with a long, narrow funnel, so as to reach the surface of the acid; every drop of the spirit as it fell on the acid, made as great a hissing noise as a red hot iron wou'd, on dipping it into cold-water: by this management very few vapors rise, and these cease intirely the instant the surface of the acid is covered with the spirit; he further advises not to shake the retort, but to suffer both to remain, till the next day, and not to pour but 1 lb of the spirit at first and the 2d lb the next day. Experience taught him the necessity of taking all these precautions, for 24 hours after mixing the marine acid with spirits of wine, all his vessels burst with explosion; about the 11th day, the acid from limpid began to go thro' different shades of yellow to that of cinnamon, and being incorporated with the spirit, then exhaled the odor of sack; he now shook the retort, the mixture became scarce warm, no vapors arose; he placed the retort in the sand

sand of a lamp-furnace, luted the junctures very exactly, and leaving the whole in a cold digestion for 15 days more, he then lights a match of 24 fine cotton threads; at the end of 48 hours 4 oz only of lightly aromatic spirit came over, he returned this back, he here left the matter for some few days more in digestion, and lighting after, sometimes one, and sometimes two matches, as the odor diffused in his laboratory happened to be more or less, on the 6th day of the operation, he found in the receiver 25 oz of a limpid, sweet liquor, of an aromatic smell, but no way sulphurous, upon re-luting the vessels, and continuing the operation with 2 and 3 matches, an aqueous liquor, but no way sulphurous, came over, this was followed by another, together with a little essential oil, of a light green color; upon changing the receiver, and increasing the number of the matches to 4, a good deal of a lightly acid *flegm* came over, of a penetrating sulphurous smell, and yet very little oil was obtained, tho' the operation had been continued for 13 days and nights; however, as M. *Geoffroy* by these trials found, that by employing a lamp-heat, the matter in the retort became more tractable, and having by the preceding processes procured as much of this oil as he had occasion for, all his view now was, to discover how much spirits

a pound

a pound of the concentrated acid was able of decomposing, accordingly by continuing the same process, and adding after each operation a pound of the spirit of wine, he found that 1 lb of this acid was able to decompose 20 lb and more of the spirits; for as the remaining matter in the retort was still acid, it might aromatise some pounds more of spirit, but as this wou'd require long digestions, besides, as these operations had been continued above a year, M. Geoffroy distilled the *residuum*, till the matter acquired the consistence of a sirup, and exhaled an odor not unlike that of *elixir proprietatis*, but rather more acid: this sirupy substance weighed 1 lb. 7 oz 7 drs; this increase in the weight must be owing to the *flegm*, saline and terrene parts of the spirit; whoever wants to procure this essential oil, shou'd employ M. Geoffroy's method, *i. e.* pour the spirit on the acid; by this means the liquors mix quietly, few or no vapors exhale; they shou'd also procure the oldest and most oily spirits to be had; 3 lb of such a spirit and 1 lb of the concentrated acid of vitriol will yield the greatest quantity of this oil.

M. Geoffroy tried several ways to rectify this oil, *i. e.* to deprive it of its acid; by several lotions with water, he found the acid was absorbed, but then his oil was considerably diminished; he then dipped several cotton wicks

wicks in *lixivium tartari*, from a hint given by *Stahl* *, and suspended them in the bottle the oil was in for 12 hours, they in that time became hard and crufted over with a faline matter ; but the method that fucceeded beft was diftilling it with lime-water, in the proportion of 5 oz of the water to every *dr* of the oil ; the lime-water abforbs the vitriolic acid, and with it forms a true *selenites*.

There is ftill a more expeditious method of rectifying this oil ; pour a few drops of the moft concentrated oil of vitriol on this oil, the concentrated acid greedily attracts the weaker acid, the oil is feen to afcend to the furface of the mixture, and is found floating on the top of it.

By all thefe experiments it appears, that this oil is compofed of about 4 parts of the pure effence of wine and 17 of a weak vitriolic acid ; it might therefore be properly enough called a dulcified oil of vitriol ; but to obtain the moft of this dulcified oil, when the aromatic fpirit is come over, is the time to raife the fire, and continue it for a confiderable time.

M. *Geoffroy* by his experiments difcovered that 44 *grs* of this fweet oil of vitriol wou'd aromatife 4 oz of the fpirit of wine ; he from thence inferred, that as he had obtained near 19 $\frac{1}{2}$ lb of an aromatic fpirit from 20 lb of the fpirit of wine, that 5 oz at leaft

* See before p. 69.

of this oil must, in the 19th distillations he made, be developed and separated from the mixture, to aromatise that quantity of spirit, which with $2\frac{1}{2}$ oz he had saved in the first operation, make $7\frac{1}{2}$ oz. 1 lb of this concentrated acid had decomposed and separated from 20 lb of the spirits of wine, and as the black mass in the retort was but lightly acid, what it wanted of its acid must have been volatilized, and gone over with the several portions of this aromatic spirit. M. Geoffroy tell us, that by rectifying this spirit with dry salt of tartar to deprive it of all its acid, and with a lamp-heat drawing off $\frac{3}{4}$ only of the quantity of the spirit employed, we shou'd have a spirituous liquor, possessed of all the virtues Hoffman ascribes to his *liquor anodinus mineralis*.

Of the Basis of Alum. 1744.

By the best accounts we have of alum and vitriol, there are mines, where each are found in pure crystals that want no further preparation: it is likewise known that both alum, vitriol and common brimstone are had from the same *pyrites* *, the acid in these three concrete salts being the same.

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* Neuman assures us, that nature produces no perfect alum, but affords the materials for it in sundry ores, *pyrites*, stones, slates, earths, waters, *bitumens*, as pit-coal, the most curious alum-ore, he knew was in Sweden, where sulphur, vitriol and alum are obtained from one mineral, which appears to be a kind of *pyrites*;

The *basis* of alum is a fine earth, which by no action of fire will vitrify, but will remain united even with the glass it is mixed with; and whenever this happens, such bottles as are made of this glass will necessarily render the wine foul *. The acid in alum has been hitherto supposed to be so intimately united to its *basis*, as not to be separated from it without the utmost action of fire, yet M. Geoffroy has discovered that this acid will quit its *basis*, to join a metallic-earth or *basis*; and herein is an exception to his brother's table of affinities, where it is said that the vitriolic acid will quit a metallic *basis* to join an absorbent earth †.

M. Geoffroy's views in his experiments with *alum* was to discover the nature of this absorbent earth; he found that horse-nail-points did precipitate the *basis* or earth of alum equally as pure as salt of tartar would; for by pouring oil of vitriol on this earth, there is formed an alum in filamentary crys-

the sulphur is first extracted by distillation, the *residuum* being strongly calcined, boiled in water, the liquor duly evaporated, and set to shoot, the vitriol crystallizes, the uncrystallized liquor treated with urine and a ley drawn from ashes, yields alum, the use of urine or alkaline salt is partly to clarify the solution and precipitate such metallic parts as it may contain, and partly to give a body to the alum, and promote the crystallization; without this, the liquor would not shoot, but would remain a fluid mass, or if further evaporated, would yield only an unctuous mass. *Neum. Chem.* p. 185.

* See p. 299.

† See p. 52.

tals, not unlike those M. *Tournefort* found in the alum mines in the island *Milos*.

In proportion as the acid in the solution of alum seizes this metallic earth, it lets go and deposits as much of its absorbent earth, which to have pure, and unmixed with any of the metallic earth, it shou'd be separated while this metallic earth is yet suspended; and purified after by several lotions, otherwise when the acid in the solution of alum has dissolved a sufficient quantity of this martial earth, to compose either a vitriol, or a vitriolated alum, the superabundant martial earth remaining, precipitates and mixes with the absorbent earth of the alum, and renders it impure.

When M. *Geoffroy* by the above experiment found, that what was precipitated by the means of this martial earth, was the true *basis* of alum (as was evident by his regenerating alum by pouring the oil of vitriol on this earth); he then began to consider, that the earth in alum must be very different from common earths, and that very probably it is the calcined earth of vegetable or animal substances; what seems to confirm this is, that M. *Geoffroy* has made alum, with several calcined vegetable and animal substances and oil of vitriol, such as harts-horns, mutton bones, &c. and with the ashes of his furnace thoroughly calcined and wash-

ed after, to deprive them of all their fixed salts ; all these different absorbent earths left in digestion with oil of vitriol, yielded as fine alum as any imported ; from whence it is natural to conclude, that the basis of alum is either a vegetable or an animal earth, that had been calcined by some subterraneous fires ; nor is it difficult to conceive how this may happen. The earth abounds every where with this *universal acid*, and meeting with those calcined vegetable or animal substances in the bowels of the earth, forms with one or other this concrete salt we call alum ; the alum found in the plains of *Solfatara* near *Puteoli* in *Italy*, is certainly produced by such calcined vegetable or animal substances, united to the *universal acid* : the earth of those plains is so hot, that one cou'd not hold his hand long on it*.

*The solution and crystallization of concrete Salts,
how performed. 1744.*

By a concrete salt we here understand any salt composed of any acid, whether mineral

* How the vegetables of those plains, as also the several kinds of worms that are known to live in the earth and probably millions of other insects, at present, and perhaps will ever remain unknown to us, are calcined by such subterraneous fires, is easily understood, and how those calcined substances become a *matrix* for this universal acid, so as to produce alum, has been explained before in the note on fossil sal-ammoniac, which see, p. 148.

or vegetable, and alkali fixed or volatile, an absorbent earth, metallic substance or oil.

All salts are more or less soluble in water, and as they always assume some regular figure in their natural or crystalline form, so they are easily distinguishable by this constant regular figure of their crystals.

Chemists have long disputed how salts are dissolved, and kept suspended in water; the general opinion is, that the particles of salt are so small in themselves, and so easily separable, as to become of equal specific gravity with the particles of water they are divided between, they must therefore remain suspended in the water, and obey every motion of the element they are mixed with; for if they were lighter than the water, they wou'd float on the top of it; or if they were heavier, they wou'd preponderate and fall to the bottom.

Stahl and others attribute the solution and suspension of salts in water to their union with, and adhesion to the particles of water; the minuteness of the *molecules* of water and their natural intestine motion they consider as concurring causes only.

Be this as it may, every body knows, that to crystallize salts is to deprive them of a part of the *solvent* that kept their little solid masses asunder; when therefore this *solvent* is evaporated to a certain point, *i. e.*
when

when the remaining liquor is no longer able to keep those little solid particles asunder, they then adhere to each other, forming thereby larger and larger masses, as the water exhales, till the whole is crystallized.

Chemists have employed 3 several methods to evaporate this water; the first is by an insensible evaporation, by reason it is made in the open air, or by the heat of the sun in summer; the second is by a slow evaporation over a gentle fire, whose degree of heat exceeds that of the sun in summer, and gradually increases, till one can no longer bear his finger in the evaporating liquor; the third is by a rapid evaporation, whose degree of heat begins, where that of the slow evaporation left off, and gradually increases to that of ebullition.

By each of those methods salts are known to coalesce, and form such crystals as are peculiar to the several kinds of salts set to crystallize. *Descartes* will have this crystallization of salts to be owing to impulsion: *Newton* insists that the crystallization of all salts, as well as the cohesion of all parts of matter are owing to that mutual attraction, observable to be inherent in matter, and which is always proportionable to the solidity of its integral parts.

Becher and *Stahl* attribute it to the figure
of

of the surfaces of the integral particles of said salts.

All salts retain more or less of their *solvent*, water, in their crystallization; the less water they retain in their crystallization, the more they will require to dissolve and keep them suspended in the water, and the sooner upon evaporation will they crystallize, for instance, 2 ounces of water will dissolve but 6 *drs* and a scruple of marine salt, 1 oz 1 *dr* of green vitriol, 2 scruples and a half of nitre, 5 *drs* 2 scruples of sal-ammoniac, 2 *drs* 1 scruple of alum and 1 *dr* half a scruple of *Borax* *. When any two or more of those salts happen to be dissolved in the same water, the salt that requires more water to dissolve it will crystallize first, and upon removing those first crystals, and reiterating the evaporation, the other salts are in like manner had separate; thus, if alum and common salt happen to be dissolved together, the alum, as it requires a greater quantity of water to dissolve it, so it becomes the soonest sensible of the avolation of the aqueous particles, *i. e.* crystallizes first, and may therefore be had separate. When the crystals of alum are removed, and the remaining liquor is set to evaporate, the common salt in its turn, gradually deprived of its solvent, crystallizes, and may be had separate, as the alum was.

* See Grew's Exper. on the solution of salts, &c.

It is further to be observed, that all salts begin to coalesce first at the surface of their *solvent*; because the first particles of the *solvent* that exhale, are those at the surface; the salts abandoned there by their *solvent*, attract each other, crystallize first.

All salts do not equally yield the same regular crystals by each of the foregoing methods of evaporation: when the evaporation is insensible, performed by the heat of the sun only, the crystals are then both large and beautiful; by reason nothing opposes their natural attraction, or union; when the evaporation is over a slow fire, the crystals are yet regular, tho' not so large as in the insensible evaporation, because the fire has a little interrupted their union; but when the evaporation is performed by an heat of ebullition, by a continued, rapid evaporation over the fire, the saline parts are by this great heat tumultuously agitated, and obliged to run into all directions; and being preposterously mixed, they necessarily must form less beautiful crystals; a precipitate refrigeration of the same salts will have equally the same effect, *i. e.* produce less regular crystals; for when a solution of any salt, sufficiently warm, is suddenly cooled, by putting the vessel containing it into cold water, the dissolved salt suspended in the liquor, is by its sudden condensation forced out with a kind of *impetus*,
and

and precipitated to the bottom in the form of a powder. The best method therefore of evaporation is that over a slow fire, never suffering the evaporating liquor to rise to the heat of ebullition; the best place for refrigeration is that, where the temperature of the air is nearly like that of cellars in the months of June and July, *i. e.* which is neither too warm, nor too cold; the salts will then gradually coalesce, and crystallize regularly.

It has appeared very surprizing to some to find, that all concrete salts, let them be ever so often dissolved in water, and crystallized after, constantly assume the same figure in their crystals; thus for example, the crystals of common salt are quadrilateral pyramids, with square bases; sugar exhibits the same pyramids with oblong and rectangular bases; in alum they rise with 6 sides, supported with hexagonal *bases*; the crystals of vitriol for the most part resemble *isicles*, variously intermixed with polygons interposed, or lying between them; sal-ammoniac elegantly resembles the branches of a tree; salt of harts-horns resembles so many arrows placed in a quiver; *sal Glauberi* partakes of the figure of the salt it is composed of, its crystals are quadrilateral, terminated by *bases* of the same figure; the crystals of nitre are in prismatic columns, not unlike

bundles of sticks bound together; some rhomboidal and pentagonal crystals are often found between them, which seemed to approach pretty near to common salt; but salt of tin exceeds all others for beauty; here small lines, like needles are observed to run out in every direction from a center, so as to form a star, like what is seen in *regulus martis*.

M. Rouelle distinguishes all concrete salts into 6 classes; this distinction is taken either from the figure of their crystals, the manner these are grouped together, or coalesce and increase in bulk, during their crystallization.

Each class is divided into *genus's*, and each *genus* is divided into its *species*; the generic character of each salt is derived from the acid in its composition, and its specific character from its *base*. For example, all salts composed with the vitriolic acid, form a *genus* of salts, and the specifick character of these salts is derived from the different *bases* this acid is received into. Thus the vitriolic acid, joined to an alkali, fixed or volatile, to an absorbent earth, or to a metallic substance, forms so many different species of salts.

I. *Class*. The crystals of this class are of a foliaceous form, separate from each other; they also crystallize the soonest at the surface

face of their *solvent* in every kind of evaporation ; tho' they yield the largest and most beautiful crystals by an insensible evaporation.

The salts of this class of all others, retain the least of their *solvent* in their crystallization; and for that reason require more water to dissolve them.

These are, 1°. A selenites formed with the vitriolic acid and an absorbent earth, such as is extracted from several earths, among others from *Fuller's* earth, and many vegetable substances. 2°. A gypseous salt, extracted from the *caput mort.* of *aqua fortis* when made with vitriol, lastly *Homburg's* sedative salt.

II. *Class.* The salts of this class are either cubes, or quadrilateral and hexagonal crystals; they crystallize separate at the bottom of the pan, by an insensible evaporation, by a moderate evaporation they crystallize at the surface of their *solvent*, and the crystals are large and regular; but by a rapid evaporation, they first form a pellicle, and by a sudden refrigeration yield few crystals, and those irregular. The salts of this class retain more of their *solvent* in their crystallization than those of the first class, and for that reason require less water to dissolve them.

The vitriolic acid in this class forms a vitriolated tartar, the nitrous is united to mercury and lead, the marine forms common

salt and regenerated common salt; and the vegetable acid forms tartar.

III. *Class.* The salts of this class form crystals, whose figures resemble tetraedrons, pyramids, parallelepipeds, rhomboids, parallelepipedo-rhomboids, whose angles are variously truncated. They crystallize separate, few of them unite at their base, but they change their figure on their union, or according to some circumstances in their evaporation and refrigeration. By the insensible evaporation almost all the salts of this class form large and regular crystals at the bottom of their *solvent*; by the moderate and rapid evaporation and sudden refrigeration, their crystals are likewise formed at the bottom of their *solvent*, but in a confused manner and irregular; they retain a good deal of their *solvent* in their crystallization, and on that account they require a stronger evaporation to crystallize them. The vitriolic acid is here united to iron, copper, alum, borax, white vitriol and zink, the nitrous is found in the quadrangular nitre, and united to silver and bismuth, and the vegetable acid is contained in sugar, *Seignette's* salt, emetic tartar and verdigrise.

IV. *Class.* The crystals of this class are flattened parallelepipedons, whose extremities are terminated by two surfaces in opposite directions, so as to form acute angles, with
large

large parallelepiped faces. There are many of them grouped together, forming as their bases approach each other a kind of tuft.

By the sensible evaporation, they form the largest and most regular crystals, by the moderate and rapid evaporation they form a pellicle, and by a sudden refrigeration very small crystals; as these salts retain a good deal of water in their crystallization, so they require very little water to dissolve them.

This class contains the vegetable acid only, all the salts of this class being composed of it and a fixed and volatile alkali, an absorbent earth, and a metallic substance, lead.

V. *Class*. The crystals of this class are in oblong needles, prisms, or columns of different surfaces. They crystallize at the bottom of their *solvent*, grouped together in the form of tufts, or some other regular figure.

By the insensible evaporation they for the most part crystallize badly, by a moderate and rapid evaporation, a pellicle first appears, and by a slow refrigeration, if the evaporation was moderate, regular, well-formed crystals appear, floating in the solvent, which soon precipitate, but if the evaporation was rapid, the crystals appear confused and irregular.

The salts of this class, with the vitriolic acid, are a vitriolic ammoniacal salt, a *Glauber's* salt, and a volatile vitriolic salt, composed with
the

the volatile vitriolic acid and a fixed alkali; the nitrous acid forms a true nitre, a nitro-ammoniacal salt, the marine acid forms common salt, sal-ammoniac, corrosive sublimate, and horn-lead, and the vegetable acid, is here united to chalk and the volatile salt of amber.

VI. *Class.* The crystals of this class are in very small needles or of some other indeterminate figure; they will not crystallize by the insensible evaporation, and but very few of them by a moderate evaporation, they therefore require a strong evaporation, so as to be reduced to a thick consistence, and after refrigeration, they crystallize but badly. To obtain regular crystals, spirit of wine must be employed. Those salts require very little water to dissolve them, most of them deliquesce in the open air.

The marine acid is here joined to an absorbent earth, iron and copper, the nitrous is likewise joined to the same substances; the vegetable to a fixed alkali, all this is fully explained in the annexed table.

Concrete salts ranged according to their manner of crystallization.*

I. *Class.* The salts of this class crystallize separate, in very thin flat crystals, and that by the least degree of heat. Of all concrete salts these require most water to dissolve them.

II. *Class.*

* See plate XII.

II. *Class.* The salts of this class are in cubes, or in pyramids of several faces. These salts crystallize separate, but change their figures by their union. They will crystallize both at the surface and bottom of their *solvent*.

III. *Class.* The figure of the salts of this class are tetraëdrons, pyramids, parallelepipeds, rhomboids, and parallelepipedo-rhomboids. By an insensible evaporation, they yield fair and large crystals at the bottom of their *solvent*; but vary considerably, according to the circumstances attending their crystallization.

IV. *Class.* The figure of the salts of this class are flat parallelepipeds, their extremities being terminated by two surfaces inclined to one another. By an insensible evaporation they form large and fair crystals; but very small ones by a sudden refrigeration; several of these crystals unite together, in the form of tufts; however all the salts of this class are perfectly alike.

V. *Class.* The salts of this are in long needles, columns or *prisms*, and upon refrigeration, form at the bottom of their *solvent* fair and regular crystals. Many of them unite in the form of tufts, or of some other regular figure; but most of them crystallize badly by the insensible evaporation.

VI. *Class.* The salts of this class are in very small needles or otherwise badly figured; nor
will

will they crystallize by the insensible evaporation; but require a heat of ebullition; besides, to obtain any regular crystals, one must employ spirits of wine, which having a greater affinity with the aqueous fluid than these salts have, suffer them to separate freely from the *menstruum*, and so form large crystals, scarce obtainable by any other means. 1 20th part of the weight of the liquor, will in most cases be sufficient, and in some will be rather too much: all the salts of this class readily deliquiate in the open air.

The vitrum antimonii ceratum, improved. 1745.

M. Geoffroy informs us, that the great reputation this preparation acquired, as a specific in dysenteries in *Scotland, England* and *France*, induced him to examine, how so drastic a medicine, heretofore administered to the robust only, and scarce ever but in the *colica Pictorum*, became so safe a medicine. Dr. Young, who first published the manner of preparing it, tells us * it had been long given with success in dysenteries, tho' its preparation was kept a secret for many years. He further tells us, that he gave it in common and epidemic dysenteries accompanied with, or without a fever, and that whether the patient had or had not been blooded and puked, the success he found

* See Med. Ess. Vol. V. p. 162.

found was equally the same. The largest dose he generally gave was 10 or 12 *grs*, but for greater safety, he advises to begin with 6 *grs*, and in weakly constitutions, with even a less, increasing it according to its manner of operating; he observed that it operated most mildly on an empty stomach; to a boy of 10 years, he gave 3 or 4 *grs*, to a child of 4, 2 or 3 *grs*, he adds, it may be safely given to a woman with child, and to a child on the breast to half a grain. It is found to vomit some, to purge others, tho' in general without griping, or much fatigue; but whenever it should act too violently, it shou'd be given but every other morning, and a pargoric in the evening, viz. half or a grain of the *extractum thebaici* with a little venice treacle, or electar. è scordio. It is prepared thus.

Melt a dram of bees-wax in an iron lade, over a gentle fire, add an ounce of the *vitrum* in powder; keep stirring the matter with a *spatula* for half an hour, take it off the fire, and powder for use.

During this process, M. Geoffroy attentively observed the manner the wax acted on the *vitrum*, that in proportion as it dissolved, every particle was crusted over with the wax. He thence inferred, that this is what rendered this preparation so mild in action, as easily to pass off the stomach, often without exciting even a *nausea*, and so mildly thro' the intestines, as to become, not only a safe

but also a salutary medicine in all dysenteries and diarrhoea's.

From these observations, M. *Geoffroy* began to reflect, that any other sulphurous matter might as effectually crust over the *Spiculæ* of this *Vitrum*, accordingly, after it had been powdered and sifted, he had it ground into an impalpable powder on the flag, with a sufficient quantity of the spirit of wine.

This certainly is a much better way of preparing this medicine, and less liable to error. M. *Geoffroy* gave it with great success in dysenteries and all immoderate uterine discharges, and that in less than half the dose of that prepared with wax. He further adds, that it wou'd not purge some, nor even cause a sickness at stomach, tho' given to 8 *grs.* It is therefore no longer necessary to prepare this medicine with wax, as the spirit of wine as effectually sheaths its *spicule*, and thereby moderates its action, leaving the medicine to the full as salutary *.

* The chemists have long labored to discover the composition of the late famous empiric, *Ward's pill* and *drop*, and tho' they did not exactly hit on it, yet they convinced those of the profession, that they were no more than preparations of this *vitrum*, artfully disguised; and now, that both are made public, his *pill* does not seem to differ from this *vitrum antimonii ceratnm*, especially as here improved; and as to his *drop*, it visibly is no other than the antimonial wine, long known in practice to be possessed of all the virtues of that mineral, with this further circumstance

circumstance, that it readily mixes with our fluids, so as from 10 to 50 or 60 drops to become an attenuant, alterative, diaphoretic and diuretic, a few drops more purge gently, and given in a larger dose vomit strongly *.

Tho' these preparations of antimony may, in the hands of a judicious physician, be powerful and efficacious medicines in many rebellious, chronic cases, yet as they are of the drastic kind, and found primarily to affect the nervous system, and in a visible manner, display their power in the stomach, they shou'd not therefore be prescribed indiscriminately to every body, and never where there is a suspicion of any of the principal viscera's being unsound.

The preparation of Ward's pill and drop, according to the receipt published by John Page, Esq;

Take *vitrum antimonii*, q. v. pound it in an iron-mortar, sift it thro' a fine lawn sieve, grind it after on the flag into an impalpable powder, add an ounce of dragons blood in powder to every 4 oz of this levigated *vitrum*, grind them both together, and wth sack, make into a mass for pills. The full dose for either man or woman is a grain and a half bruised, and given in a spoonful of some small liquor, in the morning on an empty stomach.

The *drop* is prepared by infusing half an ounce of the same levigated *vitrum* in a quart of the richest *Malaga* or sack, shaking them well together, then letting them stand for 2 or 3 days to settle and clear, and gently pouring it off, to have it quite fine. The full dose is half an ounce, but in many cases, it wou'd be prudent to give 2 or 3 *drs* only. Both *pill* and *drop* are found to operate upwards and downwards, but with much less straining than other emetics. If it should work upwards, the patient shou'd drink sage, or baum-tea between each motion; if it shou'd raise a sweat, he shou'd keep himself warm, drink some small warm liquor of any kind, and avoid milk, greens and fruit the days he takes it.

N. Let there be ever so great care in decanting this wine, some imperceptible particles of the *vitrum* might still remain suspended, and go off with the wine, which notwithstanding the action of the wine on them, retain all their verulence. It is not with this as with many other tinctures, where the matter left undissolved is of little consequence, but every atom of this *vitrum* retains its primitive virulence, and in appearance inexhaustibly; for after 30 repeated infusions, it is scarce sensibly diminished in its weight; therefore it will be always prudent to filter this tincture thro' paper.

* See Huxham on fevers, Ed. 2. p. 230.

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Notwithstanding the greatest care in correcting the press, some few errors are retain'd, but for the most part are such as any reader may easily correct with his pen. Such only as seem'd to affect the sense are here set down.

Vol. II. p. 63. l. 82, dele *not*. P. 65. l. 11, disorderly, r. *disordered*. P. 69. l. 2. for *compress*, r. *compression*. P. 271. l. 23, r. *thermometer*.

Vol. III. p. 94, l. 7, r. *upon letting*. P. 97. l. 9, for *had only*, r. *was owing to*. P. 284. l. 26, for 4 per cent, r. *4 times its weight of silver*. P. 330, l. 12, for *subliming*, r. *upon evaporation, crystallizing with*. P. 382, l. 25, after *is*, add *it*, and in the next line, dele *it* after that. P. 386, l. 10, after *set*, add *out*.

Vol. IV. p. 2. l. 6. r. *Principle*. P. 54, l. 4. for *hands*, r. *stands*. P. 65, l. 9. for *has*, r. *have*. P. 107, l. 13, after *vegetable*, r. *animal*. P. 222. l. 13. for *following*, r. *foregoing*. P. 234, l. 14, r. *enabled*. P. 281, at bottom, r. *Plate XI*. P. 302, l. 8, for *they that*, r. *that they*. P. 350. l. 5, for *this*, r. *these*. P. 372, l. 17, for *sea-salt*, r. *salt of tartar*.

Directions for the Book-binder.

Place Plates I, II, III, IV, at the End of Vol. I,

— — — V, VI, — — — Vol. II,

— — — VII, VIII, IX, — — — III,

— — — X, XI, XII, — — — IV,